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MAGNETIC LEAKAGE.

In the design of dynamos and motors the factor which probably is under least control is the magnetic leakage. Air, although it is a poor conductor for magnetism, is not a magnetic insulator, and for this reason all magnetic circuits are surrounded by a leaky medium. The result is that it is impossible to confine the magnetic flux strictly to the path intended for it. Part of it will stray aside and allowance must be made for this straying or leakage. The amount of leakage is usually indicated by the so-called leakage factor or coefficient, which is expressed generally as the ratio of the total flux produced by the exciting coils to that usefully utilized in the armature. These leakage factors vary not only with the type of the design, but with the size of the machine and with the conditions under which it is operated. While it is possible to predetermine more or less approximately the leakage factor of any design, this involves troublesome calculations. The most reliable data we have upon the subject are those obtained from actual measurements.

The study of this leakage factor is important, but usually such investigations are limited rather to the effects of the leakage than to the conditions which bring it about and the ways in which it takes place. There have been exceptions to this, as various plans have been tried for studying the problem thoroughly, but they have generally been based upon some analogy, such as electrical conduction or the flow of liquids, because the investigation of the magnetic phenomenon itself is troublesome. The general conditions which should be brought about, as well as those to be avoided, are pretty well understood now, but there is still room for a good deal of interesting and valuable research. It may be noted that this magnetic leakage causes more trouble in the design of alternating-current machinery than in direct, because in the latter case it, in general, merely calls for a somewhat larger magnetizing element or involves more loss of energy in the exciting circuit than would be the case if leakage did not take place. In alternating-current machinery leakage not only has these effects, but, by setting up inductance, seriously affects the voltage regulation of generators and the power-factor or speed of motors. It is to avoid this leakage that the air-gaps of induction motors are made shorter than is desirable mechanically.

On another page of this issue is an interesting discussion of magnetic leakage by William Cramp. This paper first takes up the subject of direct-current machinery and then passes to alternating. It is shown in it that frequently, by rearranging the field coil, particularly by bringing it closer down to the armature, the leakage factor may be reduced. This reduction

enables the machine to be made lighter and more efficient. In general, the closer the field coil can be placed to the armature, the less opportunity there is for the flux set up to bend around the coil and reenter the pole or the yoke without passing through the armature; therefore, such disposition of the field coils tends to force the flux into the armature and thus reduces leakage.

It follows from this that if the field coil were on the armature itself there would be no leakage, since all the flux set up by the exciting coil would then pass through the armature. Such an arrangement may be secured in several ways; the armature winding may itself be used as the exciting winding as well as the winding from which the electromotive force is induced. It has been known ever since the effect of the armature current upon the magnetic field has been studied that this may be made either to assist or oppose the flux by shifting the brushes forward or backward from the neutral position. In ordinary designs this is an inefficient method of assisting magnetization, because the magnetomotive force in all cases is proportional to the product of the current and the number of turns of conductor; while the loss of energy is proportional to the square of the current and to the number of turns. It is therefore more economical to employ a small current and a large number of turns for exciting the field. In the armature, on the other hand, it is desirable to keep the number of turns of conductor down to a minimum. This difficulty could be overcome by placing two windings upon the armature, one intended to act as the armature winding proper and the other as the exciting winding. Both, of course, would need commutators. A machine of this kind has been tested by Mr. Cramp, who has found that, as was to be expected, the leakage coefficient was considerably reduced, although it was not brought down to unity. It is interesting to note here that this outcome of a study of leakage in direct-current machines is practically the same as has resulted from a similar endeavor to improve alternating-current machines; in fact, certain of the self-exciting generators and compensated commutator motors now being made depend upon a similar arrangement to improve the power-factor and to secure compensation for armature reactions. This is a good illustration of the fact that the general principles of alternating-current and direct-current machinery are the same, and that the only differences are in details. The magnetic and electric effects are the same in kind, though differing in degree.

ALLOYS.

One of the most interesting fields now being investigated both by engineers and men of science is that embracing the effects of one metal upon another when they are mixed in the form known as an alloy. In fact, one of the most striking discoveries of the last year or so was that of the so-called magnetic alloys, alloys of manganese, copper and aluminum, but containing no metal of the so-called magnetic group. Investigations of various alloys of this kind showed that certain of them possess excellent magnetic properties, although they do not in any case come up to the best magnetic iron. These alloys have had a marked effect upon our ideas of magnetism. Previously it was supposed to be an atomic property, a property belonging to the atoms of certain elements, to a greater or less degree, although its outward effects could be made more or less evident or masked by the physical conditions of the metal. Now the most promising view is that magnetism is a molecular or molar property, a property of groups of atoms or groups of molecules, rather than of atoms alone. Apparently only in this way can the magnetic properties of alloys of non-magnetic elements be explained.

Another important phase of the study of alloys is that of their mechanical properties. A small addition of one metal to another affects in a remarkable degree the properties of the resulting alloy. In general it lowers the fusing point, it affects the hardness and ductility of the alloy and it frequently increases the tensile strength. There are two types of alloys particularly interesting to electrical engineers. These are copper to which a small percentage of aluminum has been added, and aluminum containing a small percentage of copper.

The alloys committee of the Institution of Mechanical Engineers, of Great Britain, has been doing a lot of work upon this subject generally, and submitted during the past month its eighth report, which discusses the properties of these two alloys. The report deals largely with the mechanical effects, such as those produced on the ductility, tensile strength, hardness, etc., but it contains some results of interest to the electrical engineer. Excepting a few special cases, such as third-rail electric railways, copper and aluminum are the two materials used as electrical conductors. At the present prices of the materials neither one seems to have an overwhelming advantage over the other. Copper is heavy, but is a better conductor. For a given conductivity of line, in some cases the smaller diameter of the copper is advantageous; in others the larger diameter of aluminum conductors is better. Special conditions generally decide which metal will be employed, though, of course, a sudden change in price might change completely the situation.

The alloys the committee investigated included those of copper containing eleven per cent and less of aluminum. It was found that these fall into two classes: those containing up to eight per cent of aluminum and those containing from eight to eleven per cent. The first class gives metals of low yielding point, moderate ultimate stress, but of good ductility. The introduction of more aluminum increases the strength of the alloy, but hardly affects the ductility. The second class of alloys has good ultimate strength, with good ductility. One of these, the alloy containing ten per cent of aluminum, has characteristics almost exactly identical with those of a steel having the same ultimate strength. It was found that the second class of alloys gave as good results when cast as when rolled, a point of much practical advantage. These alloys are practically uncorroded by sea water, although they are affected to some extent by fresh water.

The alloys of aluminum containing a small percentage of copper also showed interesting properties. The specific gravity of chilled castings is the same as that of rolled bars. It rises regularly with the percentage of copper added. Quick or slow cooling does not affect them, but small chilled castings appear

to possess superior mechanical qualities to castings made in sand. To get the full value of the inherent properties of these alloys a considerable amount of mechanical work, such as rolling and drawing, should be performed upon them. They draw well if the amount of copper does not exceed four per cent; they roll well if it does not exceed eight per cent. Nothing is gained by adding more than four per cent of copper to the aluminum. The percentage of copper affects adversely the ductility, although it causes a rise of tenacity up to four per cent; beyond this there is but little effect. Corrosion tests showed that these alloys behaved inversely as the rich copper alloys. Those which are strongly corroded by sea water were uncorroded by fresh water. It follows from this that pure aluminum is better for cooking utensils than any alloy.

The electrical conductivities, unfortunately, were not determined for all of the alloys. One, however, consisting of copper containing one-tenth per cent of aluminum, was measured because this has valuable mechanical properties. It was found, however, that the conductivity was only 76.5 referred to pure copper as 100.

These investigations have not resulted as yet in any direct benefit to electrical industries, but it is not impossible that further research may bring valuable results. The electrical engineer is looking for light, strong materials to serve as conductors of magnetism and electricity. A magnetic conductor must have good magnetic, but poor electrical, properties; the electrical conductor should be the other way—a good conductor for electricity, but a poor one for magnetism. To-day, in order to secure the best magnetic structure, laminated sheets of soft iron or steel are used. These are good magnetic conductors, but, on account of the way in which they are built up, become poor electric conductors. Large eddy-current losses are thereby avoided. If we could discover an alloy containing iron or not which was an excellent magnetic conductor, but a bad electrical conductor, we might be able to do away with this expensive method of building up a more or less solid mass out of thin sheets. On the other hand, in lines for conducting electrical currents we wish a good electrical path, but a poor magnetic one. We wish to lose as little energy as possible due to the flow of electric current along the wire, but we wish to oppose much resistance to the creating of a magnetic field surrounding it. In other words, we wish to keep the inductance of the line down to the lowest point possible, as we thereby decrease the cost of construction by making a smaller conductor permissible and reduce the line losses and improve the power-factor, and hence the regulation of the line and of the station.

A necessary property of materials used for line construction is that they shall be strong mechanically as well as good conductors, and although a slight addition of copper to aluminum may not improve its electrical conductivity, it may so increase the strength of the conductor as to make it allowable to lengthen the distance between supports and in this way bring about an important saving in line construction. Fortunately, copper, which is the best conductor available, may be given excellent mechanical properties by proper treatment. Although the work which has been done so far in the study of alloys has not resulted in any modification of our methods of constructing dynamos, motors or transmission lines, it seems not improbable that further work may do so. There are plenty of opportunities for decreasing the weight and the cost of construction of electrical machinery and apparatus.

ELECTRIC AUTOMOBILES IN WINTER.

The recent heavy snowstorm which visited the eastern states put a severe strain on all systems of traffic. The electric railways were not alone in feeling the effects of the ten to fifteen inches of snow. The schedules on the steam railroads were badly upset, and although in some districts the trolley roads were completely tied up for a time, in others they made a better showing than the competing steam lines.

In the cities the electric lines, of course, felt some effects of the unusual conditions, but the most serious interference with traffic was that felt by horse-drawn vehicles. Ten inches of snow makes hard pulling for a heavy truck, so that blockades are frequent on busy streets. Moreover, on those streets where smooth wooden or asphalt pavements have been laid, as is true of many streets in New York city, when the snow was cleared away the slippery film of snowy ice formed made it difficult for the horses to get any hold. For this reason probably more trouble was experienced in such places, even though the pulling was easy, than it was where the snow still remained.

These conditions brought out very clearly the superiority of mechanically propelled vehicles for city purposes. The large electric and gasolene trucks, as well as the pleasure vehicles, seem to have no difficulty in getting around. On the cleared streets running was easy, and even where the deep snow remained they went through apparently without much additional effort. It frequently happened that a vehicle of this kind was able to clear a block, due to a stalled horse-drawn truck. In this way the electrically driven vehicles did particularly good work, as might have been expected from the peculiarities of these vehicles. The electrically driven truck is under better control than any other type of vehicle. It can start slowly and graduate its acceleration as desired, and the turning effort is greatest at the start. The machines are thus able to meet most successfully the strains due to heavy snow, and it was reported by one of the largest garages that they showed no effects of the increased strain, except a somewhat increased rate of battery discharge. The large vehicles could not travel as far as under more favorable conditions, but they suffered in no other way. The lighter vehicles, with a little additional charging in the middle of the day, were able to cover nearly as much ground as usual.

As mentioned above, the greatest delay to traffic was caused by the horses. These poor animals suffered not only from the excessive strain of hauling, but from frequent bad falls. Had it not been for them the delays to city traffic would have been much less. It is to be hoped that before long the large cities, at least, will be relieved of much of the delay and annoyance which the horse causes.

Tantalum Ores.

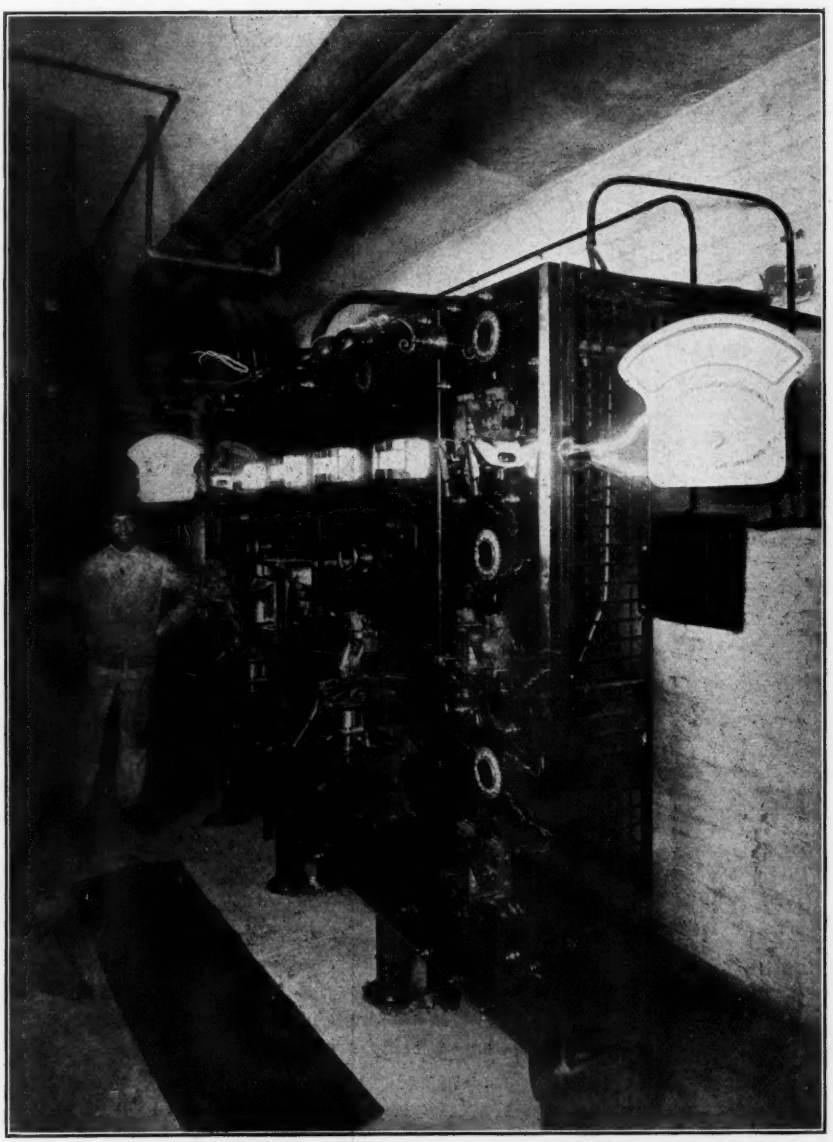
The discovery of tantalum ores in West Australia is a matter of much importance. The *Times Financial and Commercial Supplement* prints an interesting statement from a correspondent at Kalgurli, West Australia, dealing with the financial aspect of the question. Tantalum was first discovered in this state in 1894, when the rare mineral stibio-tantalite (tantalate and niobate of antimony) was identified in the tin washes of the Greenbushes tin field, near Bunbury. In 1900 tantalite (tantalate of iron) was discovered in the concentrates at the same place, and shortly afterwards large deposits of manganotantalite (niobate and tantalate of manganese) were found on the Wodgina tin field. Wodgina is situated on the Pilbara gold-field, about 160 miles inland from Port Headland. The introduction of the Siemens and Halske tantalum light furnished a market for the mineral, and in 1905 over seventy tons, valued at £8,925, were exported. This ore contains from sixty-eight to seventy per cent of metallic tantalum. The market fell away toward the end of the year, and at present there is no official market obtainable for tantalum ores. Although it is popularly supposed that the only use to which tantalum has been placed is in the manufacture of filaments for electric lights, this is by no means the case, for tantalum possesses properties which render it an important factor in steel alloys. Tantalum is a hard gray metal, somewhat heavier than iron, and is markedly ductile. At the same time, when hammered it becomes harder than the hardest steel, and has even been suggested as a substitute for diamonds in diamond drilling. Only a very small percentage of tantalum is required in these alloys. The correspondent believes that Krupps are experimenting largely in this matter, and that they, or some other German firm, are making every effort to "corner" the Wodgina fields. He adds: "The present strangulation of the market is a means to that end. The tantalum mines are few in number, and the control of fully seventy per cent of the ore in sight is vested in one company. There is no doubt that this control could be transferred to German hands to-morrow. It is simply a question of price. The presence of niobium in the manganotantalite is no longer a prohibitive factor, as recent research has shown that the niobium may be completely separated. As yet the lode has not been proved in depth, as the surface deposits have more than sufficed for all present requirements."—*Electrical Engineer, London, England, January* 11.

The Mechanical Plant in the North River Insurance Company's Building, New York City.

Among the recent installations in office buildings in New York city one of the most interesting is that installed for the North River Insurance Company at 95 William street. This is in the heart of the business district of down-town New York, and owing to the very limited space at his command, the consulting engineer, Edward R. Knowles, of New York city, had to work out a very pretty problem in supplying for a high, narrow building the proper amount of power with a very small amount of floor space.

The accompanying illustrations will give some idea of the way in which the power demands have been met. The entire mechanical equipment is on one level and occupies the basement of the building.

The boiler plant consists of three 125-horse-power Worthington boilers working at 115 pounds pressure per square inch. Coal is taken from the street into a bunker which has a capacity of about forty tons. The ashes are shoveled from in front of the boilers to an ash pit, and lifted to the street on an ash hoist. Steam is taken directly from the boilers to an eight-inch header running from the boiler room directly to the engine room, which is adjacent. From the eight-inch header loops are taken off to two Ball & Wood engines direct-connected to seventy-five-kilowatt C & C generators. Between each loop and the steam chest of the engine there is interposed a vertical separator. For the various pumps and auxiliary machines a



NORTH RIVER INSURANCE COMPANY'S PLANT, NEW YORK CITY—SWITCHBOARD.

four-inch pipe is also taken off from the eight-inch header.

The exhaust steam from the engines and from all the pumps goes to a common exhaust, and is, in turn, passed through a Webster "Star" vacuum heater, built by Warren, Webster & Camp, of Camden, N. J. All piping is lagged with eighty-five per cent magnesia, the lagging being covered with a canvas jacket sewed on from end to end.

The pumping equipment includes a Deane duplex outside-packed fire pump with a capacity of 500 gallons per minute; two duplex Deane house pumps, and two Deane boiler-feed pumps. The two latter pumps are connected in with the house pumps, and the fire pump is connected in with the elevator service. There is also a small sump pump and blow-off tank to the sewer and two Knowles vacuum pumps for the heating system.

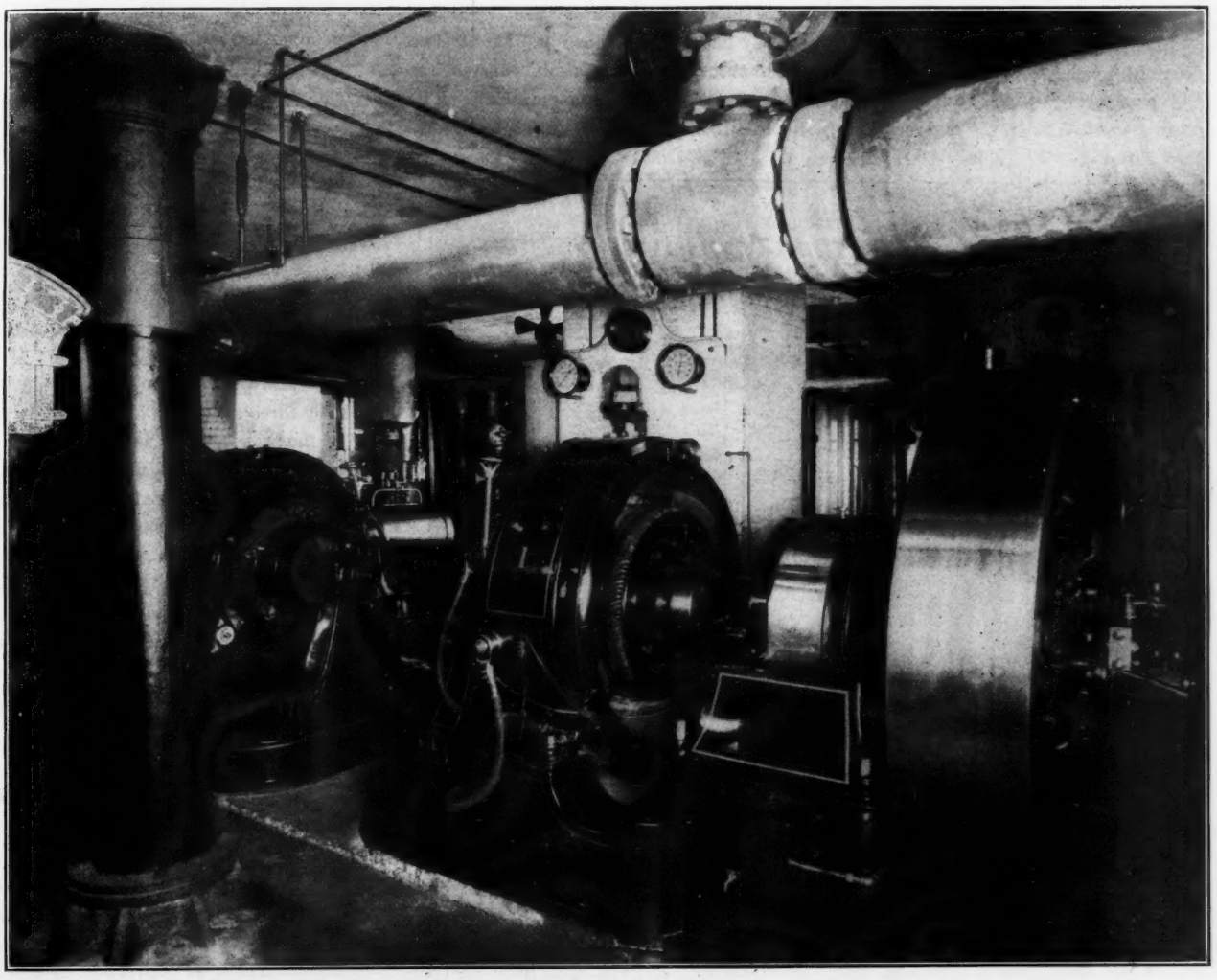
An interesting oiling system has been installed in connection with the engines, all the oil coming from a central reservoir and feeding to the oil fountains located on the head of the engine by gravity. After the oil passes through the engines it is forced back by means of a small pump attached to the engine to the common oil reservoir. This reservoir holds nine gallons of oil and is connected by a regulating feeder to each engine.

The switchboard is of black marble, about six feet by nine feet, made up of four panels supported on four fluted columns, and was installed by the F. A. LaRoche Company, of New York city. The switchboard equipment includes two generator panels and two distributing panels. Upon the board are the usual measuring instruments, supplemented by a double-reading voltmeter and a static voltmeter and ground detector. There is a pilot lamp for each distributing feeder and also for the generator circuits. Instead of ordinary knife-blade switches, each circuit is controlled by automatic circuit-breakers. These breakers are so arranged that it is impossible to close the circuit while there is any fault existing. The switchboard connections on the back of the board are made by means of heavy copper rods running to a slate platform at the top of the board. From this slate platform the connections are taken off in iron conduits and run to service boxes on each floor of the building.

In addition to the building's own plant, it is equipped so as to secure service from the New York Edison Company's mains should any accident render necessary the shutting down of its own plant. The power bus and distributing bus, however, are kept separate, and by means of a large single-pole, double-throw laminated switch it is impossible to throw the Edison service on to the power bus.

The mechanical equipment in the engine room is supplemented by a nine-inch Westinghouse air compressor supplying air to a pressure tank and to a service tank for blowing out the generators and for other cleaning purposes.

The engine room is lighted with clusters

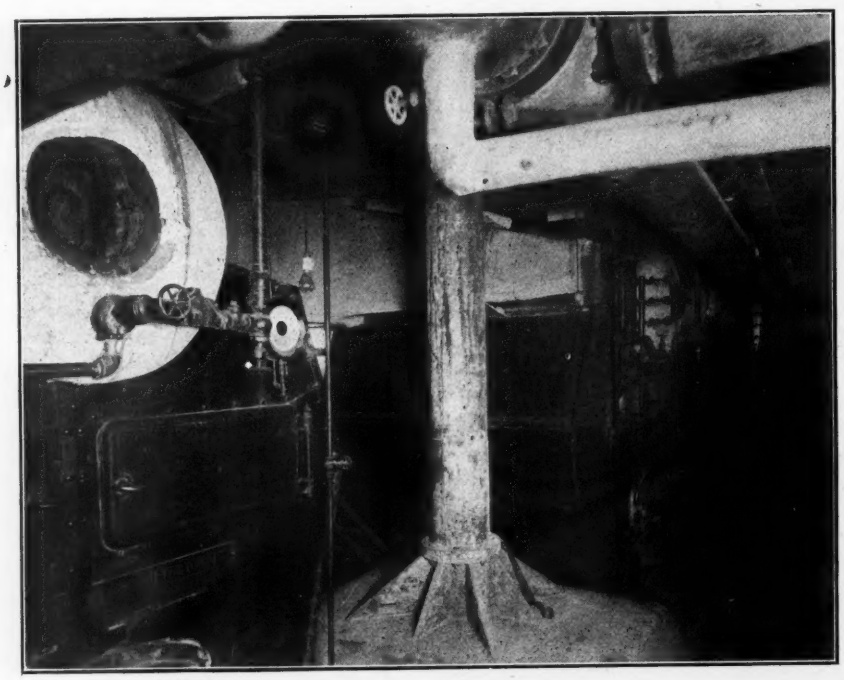


NORTH RIVER INSURANCE COMPANY'S PLANT, NEW YORK CITY—ENGINE ROOM.

of incandescent lamps, the switchboard with hooded incandescents, and the boiler room with drop lights.

The elevator equipment of the building includes two passenger elevators of the Standard Plunger Elevator Company's make, and one sidewalk lift. The elevators are driven by one compound-duplex Laidlaw-Dunn-Gordon elevator pump twelve inches by eighteen and one-half inches by ten and one-quarter inches. The elevator tank works at a pressure of 180 pounds, and is so connected that it will run one elevator at a time or both together. The elevator tank discharges into a five-inch line running to the roof tank, the end of this line going to a small tank in the basement, the elevator plungers being equipped with a check valve and keeping such a pressure at the bottom of the plungers that it is impossible for the elevators to experience any shock or cushioning effect in descending.

In addition to supplying power and light for its own building, this plant also supplies current for the lighting and power and for operating the elevators in the Gibson Building situated nearby.



North River Insurance Company's Plant, New York City—View in Boiler Room.

A Year's Work in New York City.

There is no question that the amount of work done in Greater New York during 1906 far exceeded in cost that conducted on any other equal area in the world. Even the Panama canal is far outdistanced. Most of this is directly or indirectly controlled by the engineers connected with the various city or borough departments, and which number nearly 1,000, about one-half of which have organized themselves into a society—The Municipal Engineers of the City of New York. In his annual address on January 23 the president of this society, George W. Tillson, gave a brief review of the work done in the city during the previous year, from which the following data are taken.

In subway work the Manhattan-Bronx subway has been extended and twenty-two miles are now in operation, carrying as high as 600,000 passengers a day. The North Brooklyn tube headings met December 17, and the two tunnels are expected to be in operation in April. Surveys were made for 165 miles of new routes, to cost $300,000,000, and contracts have been authorized for two—the Lexington avenue route and the Seventh, Eighth and Jerome avenues route. A route to start from Pelham Bay Park and reach Coney Island *via* Brooklyn also is ready for contract.

The dock department has built about 1,000 feet of bulkhead wall, twenty new piers, a three-story steel and concrete market building, a bulkhead wall and marginal street about one mile long. The nine piers on the North river represent the highest type of pier building ever attempted in this country. Two ferry terminals have been completed and two started.

Abolishing grade crossings in Brooklyn has involved building 7,500 lineal feet of concrete retaining wall, besides fifteen bridge abutments and 16,000 cubic yards of other masonry and 850,000 cubic yards of earthwork. Improvements have been made in the transit facilities on the Brooklyn and Williamsburg bridges, and construction work has been prosecuted on the Manhattan and Blackwell's Island bridges, 13,500 tons of steel having been put in place on the latter. Seven other bridges have been wholly or partly completed.

In connection with the water supply, the new Croton dam and west basin of the Jerome Park reservoir have been completed; considerable work has been done on the Cross river dam, and a start made on the Croton Falls reservoir. There have been constructed several driven-well stations, a seventy-two-inch steel force main, thirty-six miles of distribution mains, 1,100 hydrants, 1,500 gates and sixteen miles of high-pressure fire mains, the whole costing about $2,000,000.

The board of water supply has located sites for three reservoirs and the aqueduct line of the proposed new supply, the former involving topographical surveys of 16,000 acres, and land surveys of all included property for condemnation purposes; of the aqueduct, eighty-six miles long, about forty per cent has been located and fifteen per cent prepared for contract, this involving 550 miles of surveys and twelve miles of subsurface borings.—*Abstracted from the Municipal Journal and Engineer, New York, February 6.*

Electric Tramways in Japan.

The first electric tramway built in Japan was a line eight miles in length opened in Kyoto in 1895. Since then, says the *Mechanical Engineer* (London), other cities have in succession constructed electric tramways as convenient means of communication for short distances, so that there are now eighteen electric tramway companies, with an aggregate capital of nearly four millions sterling, whose lines already opened total 130 miles, with eighty-two miles in addition under construction. Most of the companies, however, are still in the initiatory stage, and do not yet make a very profitable business of the undertaking. That the profits will be large, however, is clearly shown by the fact that the electric tramways of Tokio already pay annual dividends of not less than ten per cent.

ON THE SUBSTITUTION OF THE ELECTRIC MOTOR FOR THE STEAM LOCOMOTIVE.[1]—III.

(Concluded.)

BY LEWIS B. STILLWELL AND HENRY ST. CLAIR PUTNAM.

The railroads of the United States in 1905 used coal costing $156,429,245. For the purpose of estimating the cost of equivalent electric power the following data are necessary, of which those marked by an * are furnished by the report of the Interstate Commerce Commission, while the others involve certain assumptions:

PASSENGER SERVICE.

*Passenger train-miles.
Passenger car-miles.
*Passenger-miles.
Average weight of passenger trains:
a. Weight of locomotives.
b. Weight of cars.
c. Weight per passenger.
Average speed of passenger trains.
Average length of run.
*Mail and express train-mileage.
Average weight of mail and express trains.
Non-revenue ton-mileage.

FREIGHT SERVICE.

*Freight train-mileage.
*Freight car-mileage.
*Revenue freight ton-miles.
Average weight of freight trains:
a. Weight of locomotives.
b. Weight of cars.
Average speed of freight trains.
Average length of run.
Non-revenue ton-mileage, work-trains, switching, etc.

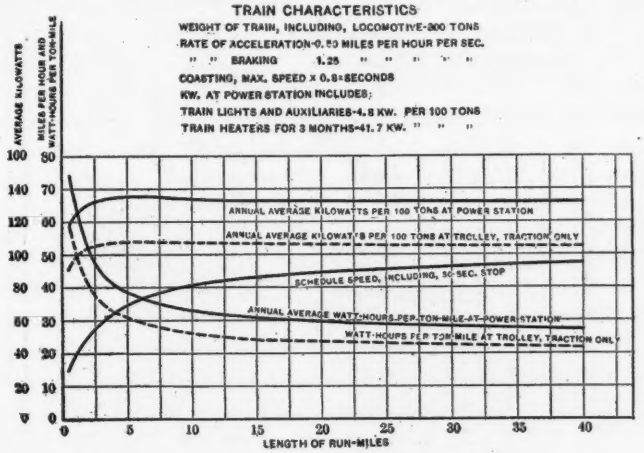

TRAIN CHARACTERISTICS
WEIGHT OF TRAIN, INCLUDING, LOCOMOTIVE-200 TONS
RATE OF ACCELERATION-0.50 MILES PER HOUR PER SEC.
" " BRAKING 1.25 " " " " "
COASTING, MAX. SPEED x 0.8=SECONDS
KW. AT POWER STATION INCLUDES:
TRAIN LIGHTS AND AUXILIARIES-4.8 KW. PER 100 TONS
TRAIN HEATERS FOR 3 MONTHS-41.7 KW. " " "
AVERAGE KILOWATTS
MILES PER HOUR AND
WATT-HOURS PER TON-MILE
ANNUAL AVERAGE KILOWATTS PER 100 TONS AT POWER STATION
ANNUAL AVERAGE KILOWATTS PER 100 TONS AT TROLLEY, TRACTION ONLY
SCHEDULE SPEED, INCLUDING, 30-SEC. STOP
ANNUAL AVERAGE WATT-HOURS PER TON-MILE AT POWER STATION
WATT-HOURS PER TON-MILE AT TROLLEY, TRACTION ONLY
LENGTH OF RUN-MILES

FIG. 1.—TRAIN CHARACTERISTICS.

Referring to the several items in the foregoing lists not directly derived from the report of the Interstate Commerce Commission, the assumptions made are as follows:

PASSENGER SERVICE.

Passenger Car-Miles—These we have calculated from the stated train mileage and the assumption that the average number of cars per train is 5.5.

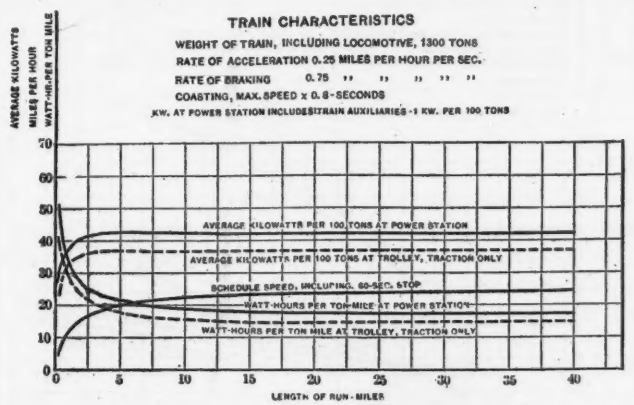

TRAIN CHARACTERISTICS
WEIGHT OF TRAIN, INCLUDING LOCOMOTIVE, 1300 TONS
RATE OF ACCELERATION 0.25 MILES PER HOUR PER SEC.
RATE OF BRAKING 0.75 " " " " "
COASTING, MAX. SPEED x 0.8-SECONDS
KW. AT POWER STATION INCLUDES:TRAIN AUXILIARIES-1 KW. PER 100 TONS
AVERAGE KILOWATTS
MILES PER HOUR
WATT-HR. PER TON MILE
AVERAGE KILOWATTS PER 100 TONS AT POWER STATION
AVERAGE KILOWATTS PER 100 TONS AT TROLLEY, TRACTION ONLY
SCHEDULE SPEED, INCLUDING, 60-SEC. STOP
WATT-HOURS PER TON-MILE AT POWER STATION
WATT-HOURS PER TON MILE AT TROLLEY, TRACTION ONLY
LENGTH OF RUN-MILES

FIG. 2.—TRAIN CHARACTERISTICS.

Average Weight of Passenger Trains—We assume,

a. Weight of the average locomotive exclusive of tender equals sixty tons; this is the weight of the average passenger locomotive used by the Erie system.

b. Average weight of ordinary passenger coaches without live load equals thirty tons. This weight is somewhat in excess of the average weight of cars used by a number of railroads using rolling stock undoubtedly representative of the average in use throughout the country. To this we have added ten per cent in estimating train weight to cover additional weight of Pullman cars.

c. Average number of cars in train: We assume five and a half cars per train which is approximately correct for a number of the more important railroads and is probably slightly above rather than below the grand average.

d. Weight per passenger: We have assumed an average weight of 140 pounds.

Average Speed of Passenger Trains—Referring to Fig. 1, the curve expressing the variation in the amount of energy required for traction as dependent upon average length of run between stations, shows that the increase resulting from a decrease in length of run from twenty miles to ten miles is but ten per cent. If the average length of run be further decreased to five miles, the increase of energy for traction as compared with that required for a ten-mile run is approximately eighteen per cent.

Including energy required for heating and lighting the cars, it is not far from accurate to assume thirty-three watt-hours output at power-house per ton-mile in average passenger service.

Average Length of Run—We have assumed, as stated, thirty-three watt-hours at power-house per ton-mile including light and heat. This corresponds to an average run of ten miles.

Average Weight of Mail and Express Trains—We have assumed average weight of mail and express trains to be the same as that of the average passenger train, *viz.*, 180 tons without locomotive or live load.

Non-Revenue Ton-Mileage—This is assumed at ten per cent to cover "double-headers" and switching. For the entire Erie system the actual figures approximate seven per cent, and the assumption of ten per cent is slightly less favorable to electric traction than the facts would probably warrant.

FREIGHT SERVICE.

Average Weight of Freight Trains—As regards freight service, in estimating the average weight of trains we have assumed the following:

a. Weight of locomotives equals seventy-nine tons. This is the actual average of the freight locomotives of the Erie system exclusive of tender.

b. Weight of cars equals fifteen tons. This figure closely approximates the aver-

[1] A paper presented at the 213th meeting of the American Institute of Electrical Engineers, New York, January 25. Condensed.

age weight of all freight cars belonging to the Erie Railroad Company.

Average Speed of Freight Trains—The curves (Fig. 2) are based upon a gear ratio which produces on straight and level track a maximum speed of twenty-five miles an hour.

Determination of the error involved by any mistake in our assumption of the average speed in freight service is facilitated by Figs. 3 and 4, which show, for example, the following relations:

Maximum Speed.	Average Speed, Including 60 Seconds Stop; Miles per Hour.	Average Watt-Hours per Ton-Mile at Power Station.
20	19	17
25	23	18
30	27	19

Average Length of Run—We have assumed that for all freight service the average length of run is fifteen miles. The actual average length of run may vary considerably from the distance assumed without causing material error in our calculation as shown in Fig. 2.

Non-Revenue Ton-Mileage—We have added fifteen per cent to the total revenue earning ton-mileage.

Basing our calculations upon the foregoing statistical facts and the assumptions noted, we estimate that for the operation of the entire freight and passenger service of the United States as existing in 1905, the aggregate energy required at bus-bars of power-houses would approximate 12,500,000,000 kilowatt-hours per annum.

At 0.6 cent per kilowatt-hour the total cost of energy for traction, for the operation of all auxiliaries, and for the supply of light and heat to passenger trains would closely approximate $76,000,000 per annum. This figure represents a saving of about $80,000,000 as compared with the coal used by steam locomotives in the year 1905.

Referring to the table, the average cost of this item for five years, *viz.*, 11.292 per cent, would be reduced by electric traction to 5.533 per cent.

Item 23. "Water supply for locomotives." This item is eliminated if electricity be substituted for steam.

Item 24. "Oil, tallow and waste for locomotives." This item should be considerably reduced. We assume that it will be reduced to 0.25 per cent.

Item 25. "Other supplies for locomotives." We make no change in this item.

Item 26. "Train service." This item is not changed.

Item 27. "Train supplies and expenses." This item among many others includes the following which will be changed by the substitution of electric motive power, *viz.*, "Heating, lighting, cleaning and lubricating cars, including the cost of supplying and pumping gas into cars."

In discussing Item 22, we have included in the estimate of electric power required energy sufficient to light all cars three hours out of every twenty-four. We have also included energy sufficient to heat all passenger trains by electricity an average of three months per annum. Both of these are important items. The cost of cleaning the cars should also be reduced by the elimination of smoke and cinders from the locomotives. All things considered we believe it is fair to assume that under electric operation this item will approximate one per cent of operating expenses.

Item 28. "Switchmen, flagmen and watchmen" will not be changed.

Item 29. "Telegraph expenses." In general it is not to be expected that the large amounts of power required for train operation can be transmitted electrically under conditions which make it necessary to parallel telegraph lines by power circuits without more or less interference with the telegraph and telephone service. Certain technical questions in regard to methods of preventing interference remain to be worked out. The erection of overhead circuits carrying power supply will involve generally more or less shifting of the location of the telegraph lines. This item of expense is taken care of in our estimate by inclusion of the cost of overhead construction, and is treated as a capital account.

Telegraph circuits being rearranged

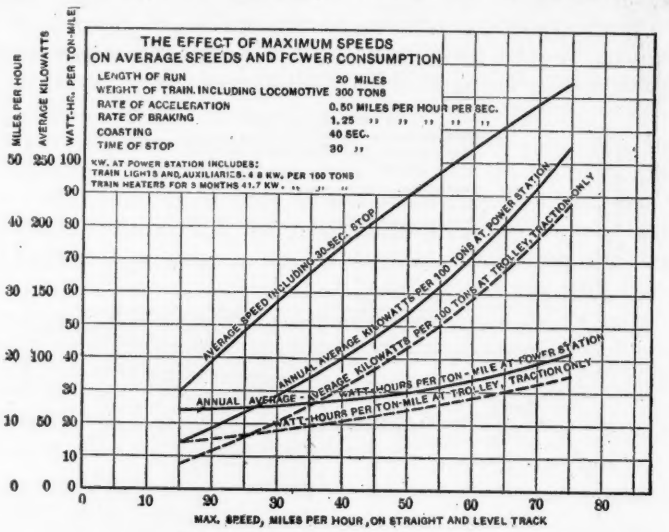

THE EFFECT OF MAXIMUM SPEEDS
ON AVERAGE SPEEDS AND POWER CONSUMPTION
LENGTH OF RUN 20 MILES
WEIGHT OF TRAIN, INCLUDING LOCOMOTIVE 300 TONS
RATE OF ACCELERATION 0.50 MILES PER HOUR PER SEC.
RATE OF BRAKING 1.25 " " " " "
COASTING 40 SEC.
TIME OF STOP 30 "
KW. AT POWER STATION INCLUDES:
TRAIN LIGHTS AND AUXILIARIES, 4.8 KW. PER 100 TONS
TRAIN HEATERS FOR 3 MONTHS 41.7 KW. " " "
MILES PER HOUR
AVERAGE KILOWATTS
WATT-HR. PER TON-MILE
AVERAGE SPEED INCLUDING 30-SEC. STOP
ANNUAL AVERAGE KILOWATTS PER 100 TONS AT POWER STATION
ANNUAL AVERAGE KILOWATTS PER 100 TONS AT TROLLEY, TRACTION ONLY
ANNUAL AVERAGE WATT-HOURS PER TON-MILE AT POWER STATION
ANNUAL AVERAGE WATT-HOURS PER TON-MILE AT TROLLEY, TRACTION ONLY
MAX. SPEED, MILES PER HOUR, ON STRAIGHT AND LEVEL TRACK

FIG. 3.—TRAIN CHARACTERISTICS.

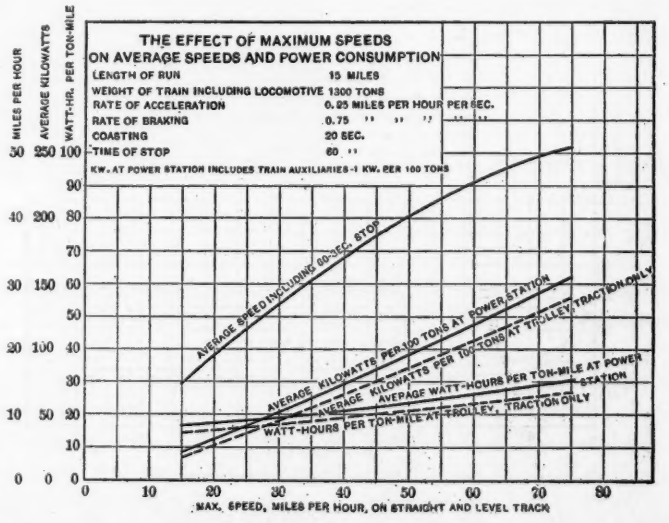

THE EFFECT OF MAXIMUM SPEEDS
ON AVERAGE SPEEDS AND POWER CONSUMPTION
LENGTH OF RUN 15 MILES
WEIGHT OF TRAIN INCLUDING LOCOMOTIVE 1300 TONS
RATE OF ACCELERATION 0.25 MILES PER HOUR PER SEC.
RATE OF BRAKING 0.75 " " " " "
COASTING 20 SEC.
TIME OF STOP 60 "
KW. AT POWER STATION INCLUDES TRAIN AUXILIARIES-1 KW. PER 100 TONS
MILES PER HOUR
AVERAGE KILOWATTS
WATT-HR. PER TON-MILE
AVERAGE SPEED INCLUDING 60-SEC. STOP
AVERAGE KILOWATTS PER 100 TONS AT POWER STATION
AVERAGE KILOWATTS PER 100 TONS AT TROLLEY, TRACTION ONLY
AVERAGE WATT-HOURS PER TON-MILE AT POWER STATION
AVERAGE WATT-HOURS PER TON-MILE AT TROLLEY, TRACTION ONLY
MAX. SPEED, MILES PER HOUR, ON STRAIGHT AND LEVEL TRACK

FIG. 4.—TRAIN CHARACTERISTICS.

with reference to the power circuits, or equipped with one or another of the devices which have been suggested as preventive of difficulties resulting from inductive effects of the power circuits, it might be assumed, perhaps with safety, that Item 29 would not be changed, but we are inclined to the opinion that there will be a slight increase in the cost of this item even under the best plans heretofore proposed, and we therefore increase it in our estimate to 0.2 per cent.

Item 30. "Station service." Examination of the factors constituting this large item indicates no material change.

Item 31. "Station supplies." This item includes among many others the following, *viz.*, "All expenditures for account of heating and lighting depots, waiting rooms, freight and passenger offices and other station buildings; fuel and supplies for engines operating freight carriers on docks, wharves and piers to convey freight between boats and cars; supplies used for stations and yards, signal lights, street lights, switch lights, semaphore lamps, etc., also bills of muncipalities for lighting highway crossings."

The ability to employ conveniently for the lighting of important passenger stations and yards, electricity delivered at the point of consumption at a cost which, exclusive of capital charges upon power plant, closely approximates 0.6 cent per kilowatt-hour, to substitute electric motors for engines now used to operate freight carriers on docks, wharves and piers, and to avail conveniently of electric hoists and telpher systems—all these are important advantages incident to the adoption of electricity. For lighting and incidental power service of this kind, equivalent to that with which railroads are now apparently satisfied, the change would undoubtedly mean reduction in cost. We will let it stand as it is, however, and would point out the fact that without increasing the cost of this item, a great improvement in facilities for handling freight at docks and wharves and for lighting passenger stations and yards will result from the substitution of electric power.

Items 32, 33 and 34, *viz.*, "Switching charges, balance," "Car per diem and mileage, balance," and "Hire of equipment, balance," will not be changed.

Item 35. "Loss and damage." Under this item the important factors which will be affected by the substitution of electricity for steam are the following, *viz.*, "Charges for loss, damage, delays or destruction of freight, parcels, express matter, baggage and other property entrusted for transportation (including live stock received for shipment) and all expenses directly incident thereto. . . . Charges for damages to or destruction of crops, buildings, lands, fencing, vehicles, or any property other than that entrusted for transportation, whether occasioned by fire, collision, overflow, or otherwise; also services and expenses of employés or others while engaged as witnesses in the case of suits."

For reasons which have been referred to in our discussion of the subject "Safety," it is clear that there should be a material reduction in the charges for loss due to destruction of freight, etc.

Another saving will result from the practical elimination by reason of damage of fire, which now not infrequently is caused by sparks from locomotives.

These savings will be offset to some extent by damage due to telegraph, telephone, or other wires coming in contact with the power circuits of the railway, unless reasonable care be exercised in preventing such accidental contact by the adoption of proper precautions when the electric equipment is installed.

In our estimate we have reduced item 35 to 0.75 per cent.

Item 36. "Injuries to persons." "This account includes all charges on account of employés or other persons killed or injured, except lawyers' fees and court expenses."

For reasons referred to under the heading "Safety" some reduction in the number of passengers and employés killed and injured in railway accidents may be expected to result from the use of electricity. The risk of fire following collision being materially reduced, we should anticipate a relatively greater reduction in the number of passengers and employés killed in accidents caused by collision or derailment than in the number injured and a reduction in the average severity of non-fatal injuries may also be expected. On the other hand, a certain number of deaths and injuries will result directly from the use of electric power in large amount, by accidental contact with charged conductors. These accidents, however, should not be frequent if care is taken in the installation and proper maintenance of the electric equipment.

As regards the expenses included under item 36 we have no data indicating how these are divided other than the fact that the railroads apparently were put to little if any expense on account of about eighty per cent of those persons other than passengers and employés who were killed and injured. While it is probable that a large part of the expenditures were on account of passengers killed and injured, and while any reduction in fatal and serious accidents to passengers therefore would materially affect this item, we have thought it best in the absence of satisfactory data to leave it practically as it stands, our estimate being one per cent.

Item 37. "Clearing wrecks." In our opinion this item will be reduced under electric operation for reasons which have been sufficiently indicated in what we have said in regard to item 35. It would seem that 0.2 per cent is a fair estimate of its probable amount.

The following items will not be changed:

Item 38. "Operating marine equipment."

Item 39. "Advertising."

Item 40. "Outside agencies."

Item 41. "Commissions."

Item 42. "Stock yards and elevator."

Item 43. "Rents of tracks, yards and terminals."

Item 44. "Rents of buildings and other property."

Item 45. "Stationery and printing."

Item 46. "Other expenses."

GENERAL EXPENSES.

As regards the several items included under the heading "General expenses," the adoption of electricity will cause no material change.

Our approximate estimate of the expenses chargeable to operation if electricity were in use to-day for the operation of all the railways in the United States, as discussed in the foregoing pages, is recorded in detail, item for item, in the last column of the tabulated data in Table I; these data with the exception of this column of estimates being the official records of the reports of the Interstate Commerce Commission. When considered in detail, the estimates are naturally subject to criticism more or less destructive, as in respect to many items we have not found opportunities to secure and investigate the great mass of detailed data showing in segregated form the scores of factors which are included in the aggregates appearing as single items in the summarized table of operating expenses; but while recognizing fully the imperfections and incompleteness of the attempted comparative analysis, we believe that the conclusions reached are correct within a reasonable degree of approximation.

According to our estimate, if all the railways of the United States were to-day operated by electricity, using the single-phase alternating-current system at the potential adopted for the equipment of the New Haven Railroad, the energy re-

quired for operation being developed by power plants such as are to-day in extensive use and transmitted at potentials well within limits established in practical service, and if the rolling stock equipment consisted of locomotives and multiple-unit trains fitted with motors and control apparatus no better than the best which now exist, the aggregate cost of operation which in 1905 amounted in round numbers to $1,400,000,000, would be reduced by about $250,000,000.

To accomplish this result power plants delivering about 12,500,000,000 kilowatt-hours per annum would be required. Assuming the radius of transmission from power-houses to be 150 miles, the load-factor in railway service should be not less than 0.75, and taking this figure it appears that power plants capable of delivering a maximum output of about 2,800,000 kilowatts will be sufficient to operate the entire railway service of the United States as existing in the year 1905. The average output required is about ten kilowatts per mile of line and seven kilowatts per mile of track.

In 1905 the average gross earnings of our railroads per mile of line were $9,598, and the average operating expenses $6,409. The foregoing calculations lead to the conclusion that high-class electric equipment now available would reduce this average cost to $5,265. The difference is $1,144 per mile of line, against which apparent saving must be charged the annual interest and depreciation of the power plant, the addition to permanent way equipment, comprising overhead construction and track bonding, the transmission circuits, and the substations with their equipment. Assuming five per cent interest on cash cost of these items and allowing five per cent for a sinking fund to cover depreciation of power-house with its equipment and 2½ per cent for a sinking fund to cover depreciation of the overhead construction and distributing system, the aggregate of fixed charges works out at $837 per mile of line. The saving in operating expenses, therefore, is more than sufficient to take care of the increase of fixed charges. In other words, it appears that the entire railroad system of the United States could be operated to-day at less cost by the electric motor than by the steam locomotive. That the railroads in general if so equipped would realize a large increase in earning power will be admitted by all who have given the subject intelligent attention.

In charging against electric operation five per cent upon cost of power plant and 2.5 per cent upon overhead construction, transmission circuits, substations and track bonding, we have departed from methods usually adopted in financing of American railway properties. If no depreciation be charged against the increased capital account represented by the items named, the apparent saving will be materially increased.

While our estimates have led us to the conclusion that, under average existing conditions of railway operation in the United States, improved financial results would be attained by the substitution of the electric motor for the steam locomotive, the immediate and general adoption of the new motive power by our railroad companies is neither possible or desirable. It requires no argument to demonstrate the wisdom of making haste with deliberation in a matter involving interests of such magnitude as those which are tied up with the transportation systems of the United States. Recognizing the magnitude of these interests and having in mind the fact that the art of electric traction as applied upon a large scale to heavy train units is yet young, the point which we desire here to emphasize is the necessity of conservative and carefully considered action upon the part of all members of this Institute who may be called upon to advise in respect to the electrification of railways now operated by steam.

Referring to the accompanying tabulated results, in which we have applied the estimated reductions in operating expenses under electric traction, amounting to eighteen per cent of the present average operating expenses to the ten geographical groups into which the railroad systems of the United States are divided by the Interstate Commerce Commission, the relatively great advantages of applying electric traction to systems operating heavy traffic showing large gross earnings per mile of line are evident at a glance.

TABLE II.—Comparison Per Mile of Line—By Groups, Steam and Electric Operation (216,974 Miles Represented), Dollars Per Mile of Line Per Year.

Group No.	General Location	Miles of Line Represented	Gross Earnings	(Steam) Operatidg Expenses	(Electric) Operating Expenses	Difference Steam and Electric Operation	5% interest on Electrical Equipment Excluding Rolling Stock.
I	New England.	8,094	$14,511	$10,493	$8,604	$1,889	$647
II	New York, Pa., et al.	23,281	20,752	13,671	11,210	2,461	790
III	Ohio, Ind., Mich.	25208	12,483	9,198	7,542	656	640
IV	Virginias, N. and S. Carolina.	12,542	7,359	4,590	3,764	826	484
V	Kentucky, Fla., Louis, et al.	24,563	6,867	4,899	4,017	882	475
VI	Ills., Wis., Dakotas, Ia., et al.	48,672	8,021	5,169	4,239	930	525
VII	Mont., Neb., and Wyoming.	11,546	7,737	4,092	3,355	737	461
VIII	Colo., Ark., Missouri, et al.	30,456	6 362	4,308	3,533	775	461
IX	Texas and New Mexico.	14,875	5,588	4,108	3,369	739	445
X	Pacific States.	17,737	8,439	4,880	4,002	878	464
	United States, Total.	216,974	9,598	6,409	5,255	1,154	516

THE STANDARDIZATION OF ELECTRIC RAILWAY TRACTION EQUIPMENT.

Electricity, entering the field hitherto occupied exclusively by the steam locomotive, encounters conditions which greatly emphasize the necessity of prompt standardization of engineering practice. The management of our railways, beginning by electrifying terminals, tunnels, and mountain-grade divisions, will inevitably be led to extend these zones of electrification until they include divisions of very considerable length, and even trunk-line systems. To call attention to the transcendent importance of standardizing the location of such additions to permanent-way equipment as the overhead trolley conductor and the third rail, is to demonstrate its necessity.

Electrical engineers now generally recognize the great value of established standards of frequency and potential in plants installed for lighting and power purposes. In recent years, the Institute, through its Standardization Committee has done splendid work for the manufacturer of electrical apparatus, as well as for the investor, by using its influence to promote the adoption of standards. Not many years ago, however, manufacturing companies, and consulting engineers, were in many cases prone to put forward or specify apparatus without reference to its ability to operate effectively in conjunction with other central station equipment, even when the latter was in actual operation in the immediate vicinity of the new plant.

In the railway field, obviously, general

principles are the same as in lighting; but wise foresight is more necessary and failure to exercise such foresight at this date less excusable. Obviously, it is of the utmost importance that they who accept the responsibility involved in the substitution of electricity for steam in the operation of certain parts of our great railways, should avoid fancies or fads and should in every way cooperate in the great work of evolving promptly standards of electric railway practice which shall withstand the test of time. The comparatively small beginnings of to-day will in all probability extend with a rapidity which we can not now realize, and the confusion and loss which will inevitably result in the near future, if a variety of electric equipment be grafted at different points upon the existing railroad systems now operating by steam, may be imagined.

Where to-day are the "16,000 alternation" system of lighting, the "15,000 alternation" system of lighting, the "constant-current alternating-current arc light system," the "forty-cycle system" and the "monocyclic system"? Where ten years from to-day will be the 1,200-volt, or the 1,500-volt, direct-current systems which have been suggested as substitutes for high-potential alternating-current systems in heavy electric traction?

While emphasizing the great importance of the early establishment of standards in the field of heavy electric traction, it must be recognized clearly that further inventions are liable at any time to modify views based upon present knowledge. The work of standardizing, therefore, should proceed with caution; but surely if present knowledge, not only of existing apparatus but of the lines along which applicable improvements must take place, is not sufficient to justify conservative application of the principle of standards, it is not sufficient to justify the investment of the very large sums which are now being expended for electric equipment.

Engineers constituting the membership of this Institute owe it to themselves, as well as to their clients, to use every effort without prejudice and without fad, to prevent waste by opposing the introduction of apparatus which, from its limitations, can not solve the general problem of railway electrification; and it is to be hoped that they will use their united influence to fix proper standards as rapidly as this establishment may be consistent with progress.

Fortunately, knowledge of the possibilities and limitations of electric apparatus to-day is a very different thing from what it was in the early days of electric lighting. At the present time we have available theory so complete that electric science is less exact only than the science of astronomy, and in applying this science in constructive work agreement between results carefully predetermined by calculation and those realized in practice is far closer than in any other comparable branch of engineering. There can be no doubt that it is possible to-day, in passing upon such a question, for example, as that of best frequency for railway operation, to make a choice which shall withstand the test of time.

The necessity of proper standardization is obvious. Specifically, it would seem feasible and eminently wise to agree upon standards of practice in respect to the following:

a. Location of third rail.

b. Location of overhead conductor used with single-phase alternating-current system.

c. Frequency of alternating-current traction systems.

It is equally desirable, but probably less easy, to agree upon a standard system of multiple-unit control for train operation.

THE QUESTION OF FREQUENCY.

While appreciating thoroughly and desiring to emphasize the importance of establishing and maintaining standards, it is also of the greatest importance that standards should be wisely chosen. The choice should be made, if possible, with full knowledge of the essential factors involved, and correct perspective view of their relative importance. It is with the feeling that so far as the frequency twenty-five cycles per second may be said to have become established, considerations obvious at first glance, but not properly controlling, may have influenced the choice unduly, that we desire to present for discussion the very important question whether twenty-five cycles per second or a lower frequency, *e. g.*, fifteen cycles per second, is best adapted and should be established as a standard in the equipment of railways by electricity.

Final decision of such a question should be left neither to manufacturing companies, the management of which may be unduly influenced by commercial considerations, affecting its own immediate prosperity or convenience, nor should it be left to the individual consulting engineer. It is precisely the kind of question which the Institute should pass upon by the adoption of a recommendation carefully considered by its Standardization Committee. The manufacturing companies, which are largely and very influentially represented in the body of the Institute, will doubtless be willing to cooperate in the collection and study of the facts requisite to the formation of a well-grounded report.

While the adoption of a standard by the Institute has the force only of a recommendation, the American Railway Association perhaps might deem it wise to indorse the choice of the Institute. Such action on the part of these two bodies would go far definitely to establish the standard.

Comparing the relative advantages of twenty-five cycles and fifteen cycles in railway service, the salient advantages of the former are the following:

1. It is to-day in extensive use in plants developing and distributing energy for lighting and power purposes, and through substations equipped with converters for the operation of many interurban lines. It has been adopted on a very large scale by such companies as the Interborough Rapid Transit Company of New York for the operation of its subway, surface, and elevated lines, by the Pennsylvania and Long Island railway companies for the electrification of New York terminal service and operation over a considerable part of Long Island, and by the New York Central for the electrification of its terminal service. It is also the frequency developed by all of the great power plants at Niagara Falls, and from this source of power it is possible for all railway lines within a radius of 150 miles, or an even greater distance, to procure an ample supply of very cheap power.

It has been adopted by the New York, New Haven & Hartford Railway Company, the pioneer among American railroads in the adoption of the alternating-current motor in heavy railway traction, and by the Grand Trunk Railway for the electrification of the Sarnia Tunnel. Alternating current at twenty-five cycles is also utilized without the interposition of converters by the motor equipment on a dozen or more interurban trolley lines.

2. Our great manufacturing companies have drawings, patterns, and dies which enable them to manufacture conveniently and promptly practically all power-house and substation equipment required for twenty-five-cycle apparatus. The weight of this consideration, however, is somewhat lessened by the fact that the march of progress—just now greatly accelerated by the general adoption of steam turbines—will undoubtedly cause a large proportion of existing drawings and patterns to be superseded probably in the very near

future and certainly within the next five years.

3. The twenty-five-cycle system is preferable to the lower frequency in the design of turbo-generators, since it affords wider range within which to select speed units of various outputs. For very large units a frequency of fifteen cycles, for example, requires either a two-pole generator operating at 900 revolutions per minute, a four-pole generator operating at 450 revolutions per minute, or a six-pole generator operating at 300 revolutions per minute. Reduction in the number of revolutions per minute implies increase in diameter of the revolving element of generator and turbine, and in machines of large output the diameter of the revolving element in turbines of certain types may become too large for shipment in view of the limitations imposed by tunnels.

4. A frequency of twenty-five cycles permits convenient and effective lighting of yards and shops by incandescent lamps. It is also more favorable than a lower frequency as regards operation of induction motors for shop purposes.

For lighting and general power purposes in cases where service for lighting purposes that shall be thoroughly satisfactory in respect to voltage, regulation and continuity is requisite, commercial supply at twenty-five cycles would be preferable. Through the interposition of motor-generator sets or converters in combination with storage batteries in such cases either frequency is applicable.

5. The higher frequency possesses some advantage in respect to the ratio of tractive effort to weight upon drivers. The best information available to date appears to indicate that the difference between twenty-five cycles and fifteen cycles in respect to this consideration probably approximates ten per cent. Further data from actual tests are desirable, and must be obtained before it is possible to estimate closely the weight of advantage possessed by the higher frequency.

6. The higher frequency is preferable for induction motors in railway service requiring a considerable range of speed adjustment. The force of this consideration depends upon the probability of using induction motors for traction purposes, and applies not only to the excellent three-phase motors, such as are in very successful use upon the Valtellina line, but also to the single-phase induction motor which, perhaps, is not beyond the range of probability. It is probable that in any general electrification of our railway system, induction motors will play a part by no means unimportant.

Without attempting detailed discussion, it is evident from the foregoing brief statement of the more important considerations in favor of twenty-five cycles that extremely weighty reasons must exist if the adoption of a lower frequency, *e. g.*, fifteen cycles, is justified.

While our object in raising this question of frequency is to present it for discussion with a view to securing additional data and, if possible, a careful consideration of this very important question by the Institute through its Standardization Committee, or a special committee, and while we desire to avoid anticipating the verdict resulting from such an investigation, it is proper to state here that consideration of the facts now available leads us to conclude that notwithstanding the number and force of the arguments in favor of twenty-five cycles, a frequency of fifteen cycles is preferable and should be adopted for heavy electric traction. The fundamental and, as it would appear, controlling reason which leads to this conclusion is the fact that within given dimensions a materially more powerful, efficient, and generally effective single-phase motor can be constructed for fifteen-cycle operation than is possible if twenty-five cycles be selected.

Final decision of the question whether the advantages of the fifteen-cycle motor as compared with the twenty-five cycle motor in respect to dimensions, weight, efficiency, power-factor, and commutation are such as outweigh the many and important considerations which favor the higher frequency, requires more complete data than we have been able to secure up to the present time. That the difference is material, however, is established not only by general theoretical considerations of the effect of a reduction in frequency upon the design and performance of single-phase commutating motors, but also by the following facts:

1. In the case of multiple-unit equipment of passenger cars where locomotives are dispensed with and motors carried upon the car trucks, it is very important that the dimension of motors be reduced to a minimum. Cars weighing, say, thirty-five tons without equipment and operating on straight and level track at speeds of from sixty to seventy miles an hour, require but two motors, except as it may become necessary to employ four motors by reason of lack of sufficient clearance at cross-overs. The difference between a two-motor equipment and a four-motor equipment in such a case approximates $2,500 per car, besides which the four-motor equipment adds materially to weight, practically doubles complication, and for both of these reasons increase cost of operation. The difference between the dimensions of a fifteen-cycle and a twenty-five cycle motor may easily be the controlling consideration compelling the adoption of the four-motor equipment.

2. In the application of single-phase commutating motors to locomotives in general railway service, the minimizing of motor dimensions is, perhaps, still more important, although in this instance the limitations imposed by the space available are less obvious.

High-speed passenger locomotives at least should be gearless. For any assumed limits of weight per axle and length of wheel-base, that frequency is preferable which permits the construction of a motor which will exert the greater pull at the draw-bar, provided efficiency, commutation, and power-factors are substantially equal. It seems probable that within given limits of dimensions, fifteen-cycle motors would materially surpass twenty-five-cycle equipment in this respect.

3. There can be no question of the superiority of the fifteen-cycle motor in respect to the very important features, commutation, efficiency, and power-factor.

In order that the question raised may be looked at in proper perspective the following estimates based upon foregoing calculations will be useful:

For the equipment of the entire railway system of the United States as now existing an aggregate power-house equipment capable of supplying continuously 2,100,000 kilowatts would be required. Of the electric apparatus installed in the power-houses, a change in frequency affects the generators, transformers, and a large proportion of the measuring and indicating instruments. It also affects the cost of the engine or turbine employed to drive the generator. At twenty-five cycles, the apparatus affected by frequency should cost approximately $30 per kilowatt. At fifteen cycles it would cost on the average perhaps $33 per kilowatt. Cost of substation transformers would be increased approximately one-third, and, in round numbers, the total cost of turbines and electrical power-house and substation apparatus would be increased from $70,000,000 to $80,000,000.

If it be assumed that one electric locomotive will do the work of two steam locomotives, about 24,000 electric locomotives would be required to take care

of the present railway business of the country. Assuming the cost of the average electric locomotive to be $25,000 the aggregate cost of locomotives required would be $600,000,000. Allowing for the increased cost of the fifteen-cycle transformers it would seem that the difference in cost of the average locomotive should be not less than $1,000 in favor of the lower frequency, or for 24,000 locomotives $24,000,000. This is more than twice the estimated difference in cost of power-house and substation equipment.

It seems entirely safe to say, therefore, that the aggregate first cost of electric equipment and of steam turbine will be decreased by a change from twenty-five cycles to fifteen cycles. The operating cost will obviously be decreased very materially. At least three-fourths of the above estimated cost of electric locomotives, say $450,000,000, represents cost of electric equipment. Of the apparatus which our electrical manufacturing companies may be called upon to furnish, more than eighty-five per cent is rolling stock. Obviously, any argument in favor of twenty-five cycle equipment which may rest upon existence of drawings and patterns and convenience in manufacturing should have comparatively little weight.

The use of fifteen cycles instead of twenty-five cycles also secures considerable advantage in respect to the overhead trolley conductor and track return. With a given limit of voltage-drop, this advantage may be utilized by reducing size and, consequently, the cost of the overhead copper and the copper used to reenforce the track return.

Under the plans which we have assumed as a basis of our calculations, the amount of copper required for feeder circuits, trolleys and reenforced track return, estimated at twenty cents per pound, would cost approximately $750,000,000 were the entire railway system of the country as existing in 1905 to be equipped for electric operation.[1]

At the close of 1906 the system of the New York Edison Company supplied electric current through 66,033 meters to 2,461,261 incandescent lamps, 32,320 arc lamps, 139,168 horse-power in motors. Additional installations in storage batteries, heating appliances and other devices, brings the total installation of Manhattan Island alone to 4,762,218 equivalents of sixteen candles. The net increase for the year of 1906 was 10,618 customers, 477,590 incandescent lamps, 7,978 arc lamps, 31,483 horse-power in electric motors and other equipment, which brought the total increase of the year to 1,007,383 sixteen-candle-power equivalents.

[1] In all our estimates we have included 0000 copper conductor in the return circuit, this being bonded to the rails at intervals for the purpose of preventing dangerous potential on track in case of a broken bond.

COOLING TOWER PRACTICE.

BY JOS. H. HART, PH.D.

There is no doubt that the cooling tower in railway and electric light power plants has come to stay. Although a somewhat modern development in engineering its progress has been rapid because it satisfies a long-felt want and it involves no new or radical engineering problem. In spite of this, and largely on account of its rapid progress, cooling tower engineering to-day is in a chaotic state, and best conditions for operation and construction and installation under given external conditions are practically unknown.

Cooling towers serve simply one purpose in a variety of applications. They serve simply to cool water from a fairly high temperature to a sufficiently low one to enable the water to be used over and over again. Thus in power plant practice cooling towers are used to cool the condenser water from its temperature after it has absorbed the steam to a low enough temperature to repeat the process. In refrigeration it does the same for the ammonia condensers and as it is efficient in almost any size unit its range of application is great. It is useful under two existing conditions; first, the scarcity of water, or its large cost, and, second, the impurity of the water for special purposes. Thus the water may contain salts, sediment, or other impurities that render it absolutely useless for boiler work. Large and expensive filters must be utilized often and these rapidly wear out or the filtering material must be renewed. In addition chemicals must often be used to soften the water. Further, a large quantity of water is required for condensing purposes. If this is allowed to run to waste the amount is often very great and a water bill ranging from $5,000 to $20,000 is not an unusual feature in many power plants. The object of the cooling tower is to cool the water by means of air currents so that it may be used over and over in the condenser and the boiler as well. The loss is simply that due to evaporation and leakage and can be renewed easily from meters or by any other available method. The water problem has become so pronounced in large unit power plant practice that until recently it was regarded as an absolute necessity that a large amount of suitable water be available at small cost in the immediate vicinity. The cooling tower eliminates this condition largely and power plant practice is no longer hampered by this often unsatisfactory condition. In practice all cooling towers can be divided into two classes: those that utilize an artificial air-blast to cool the water, and those that use natural draught. Until recently it was thought that the artificial air-blast type was more efficient, but experience and further knowledge has shown that this is not necessarily the case. The problem in cooling tower practice is simply an engineering one. A certain quantity of water at a certain temperature must be cooled to another fixed temperature in a certain time. The water possesses so many British thermal units of heat and this heat must be taken from the water by the air. Air absorbs heat in two ways: by heating itself from direct contact with the water, and by the evaporation of water vapor into the air. The first feature is practically negligible, since the specific heat of air per unit volume is small and it is also a poor conductor and heats slowly. The other feature, the evaporation of a portion of the water into the form of vapor which is carried off by the air, is very efficient, although this latter feature depends upon what is known as the relative humidity of the air. Air possesses the property of carrying in it a certain proportion of water vapor, depending upon its temperature. This varies from day to day under natural conditions and gives rise to various degrees of humidity. A small quantity of water vapor taken from a liquid, however, cools it off enormously, since the liquid becomes vapor and absorbs its own heat of vaporization from the surrounding water. Thus the problem in cooling tower work is simply to get large quantities of dry warm air in very intimate contact with the water for as long a time as possible or, at least, until the air is saturated or has its maximum humidity. The carrying power of air for water vapor is much greater at a high temperature than at a low temperature. Thus we have the anomaly that dry, hot air will cool off water quicker and better than cold, dry air. Loss in efficiency due to the temperature of the air is more than compensated by this increased absorptive power for water vapor. Air can only carry a small quantity of water vapor, relatively, and hence large quantities of air must be used. The method of utilizing a forced blast to drive air over the water is now considered objectionable owing to the fact that the air very rapidly becomes saturated before it has passed over any considerable portion of the water, and the remainder of its passage is practically inefficient as far as cooling effect is concerned. The large surface for exposure to the air is obtained in a number of ways, by overlapping wooden planks

or platforms, shavings sometimes, and a number of other devices. In cooling tower work the main features, from an engineering point of view, to be considered are reliability, durability, first cost, and efficiency. We will consider the items in the order named.

As far as the reliability of the cooling tower is concerned, it is subject only to weather conditions and accidents to the machinery. As the machinery consists merely of a pump and a blower, this feature is no different from ordinary power plant practice and the reliability factor of this unit can be considered on the whole as greater than the others involved. The weather conditions enter primarily in their effect from the deterioration factor, the freezing of the water and the humidity of the air. In steam plants the condenser water enters the cooling tower fairly hot. It is not cooled sufficiently in its passage to freeze, and even in the coldest weather a cooling tower for this purpose undergoes no serious inconvenience.

With regard to durability it can be said now that the problem has not been satisfactorily solved. Wood and iron are the main constructive materials used at present. Shavings, mineral wool, slate, and a number of other materials have been utilized in an attempt to give a large surface to the water for the air in contact with it. The two main features in the construction involve a slow flow of water, with constant movement presenting new surfaces, and large quantities of air constantly renewed. These two materials under these conditions are extremely destructive in their effects on most building materials. Wood rots rapidly away, and it is almost impossible to keep steel and iron in good condition. The iron is often painted with cement, but even this requires steady attention and the problem can not as yet be considered as other than at its inception.

With regard to first cost cooling tower outfits vary considerably in cost of installation and maintenance. Constructed simply of a pile of wood in a frame, the parts overlapping so as to present a maximum path for the flow of the water and open to the air, it is extremely simple and cheap in construction and fairly efficient. A large steel tank with large capacity rotary blower installed, forcing the air throughout the tower, is a considerably different proposition and the cost is relatively greater. When the humidity of the air is high, over eighty per cent, the cooling tower becomes extremely inefficient, but this seldom occurs in practice. The installation of a cooling tower does not entirely eliminate the water bill, as the cooling of the water 100 degrees generally involves loss in weight of fifteen per cent by evaporation. However, when the water cost is great in a power plant a considerable sum can be spent in this department with a great saving. No figures can be given, except in a general way, as each problem must be settled for its own peculiar conditions.

From an efficiency point of view and what has been said before, it can be readily seen that the efficiency in almost every case depends on special conditions. With an average of fifty to sixty per cent humidity, such as is common in the temperate zone, cooling towers have been utilized efficiently in refrigeration work, and here the requirements are much greater. The water generally enters the cooling tower much colder and leaves the tower much colder than in steam work. Hence the quantities of air, or the work required of the blower and the size and, hence, the first cost factor, and the pumping feature all become of greater significance. It can be stated off-hand that even with a fairly good supply of natural water for condensing purposes, if the water is at all impure and requires much treatment before injection into the boiler, it pays to use cooling towers. If, in addition, water is scarce or expensive, in power plant practice there is no doubt of its utility. In refrigeration the question is not so decisive. Much depends on local conditions. The high average humidity may render its adoption almost prohibitive in some cases, owing to large size and small capacity of the machine.

It can also be stated off-hand that in the present state of its development it probably does not pay to install expensive cooling towers. They can be put up for little or nothing and kept in fairly good condition with attention and renewals. The recent application of mechanical refrigeration to the freezing of moisture out of iron furnace blasts may ultimately find its way into a similar development for cooling towers, but this is dependent largely on the efficiency of mechanical refrigeration as developed from exhaust steam, and the whole subject is so complicated from an efficiency point of view that standard forms and conditions for cooling tower practice will not be at hand for a number of years.

Gas Engines for Generating Electric Power.

In this section of a serial dealing with the planning and construction of the power plant, A. E. Dixon discusses the features of gas engine operation which affect their use for electrical power stations. The gas engine offers an interesting possibility in the line of a mixed system of distribution—that is, a central gas plant from which the gas is piped to gas-engine-driven substations close to the local centres of distribution. This idea is feasible, as coal gas is at present being piped over distances of from ten to forty miles. In the latter case it is pumped at a pressure of ten pounds per square inch. In Ohio natural gas is conveyed nearly 200 miles by the use of pumps or compressors. Experience has shown that the transmission losses of such pipe-lines are small, and that they are said to be less liable to interruption than the usual overhead electric transmission line. With gas-engine-driven substations the main generating plant would be done away with, or, rather, the electrical equipment would be at the substations, and the current would be generated to suit the demands of the localities served. The rotary converters and transformers inseparable from high-tension electrical transmission would be altogether avoided. A feature affecting the economy of a gas-driven plant arises from the fact that the standby losses are greatly reduced as compared with steam plants. In certain plants a sudden thunderstorm often runs the load up 10,000 kilowatts in a few moments, and to cover such emergencies causes a high standby expense when driven by steam. Of the two types of gas engine—the two-cycle and the four-cycle—the two-cycle engine is thought to be not so well suited for high speeds as the other, owing to the fact that at high speeds the number of explosions is increased, and there is difficulty in keeping the cylinders cool. This is particularly the case when gases of high calorific value are used. In addition, the methods of governing this engine have not been able to ensure the speed regulation obtainable with the four-cycle engine. For these reasons the two-cycle engine is not as suitable for driving electrical generators as the four-cycle. The four-cycle gas engine is well suited for direct-connection to electrical generators. It can be built to govern within one revolution in 400. The question of accessibility for cleaning and repairs has been well considered, and today the internal-combustion engine is as reliable as the reciprocating steam engine and costs no more for attendance. The gas engine is usually supposed to lack overload capacity, but this is due to the method of rating. The nominal rating of a steam engine leaves it fifty per cent re-

serve power—that is to say, the steam engine is rated at sixty-six per cent of its ultimate output; while the gas engine, on the other hand, is rated at from eighty to ninety per cent of its output. The cost of installation of a gas-engine plant is said to be cheaper than a steam plant with reciprocating engines, but more expensive than a steam turbine plant. In maintenance and operating expenses it is cheaper than either of the steam prime movers. It requires no more room than a steam turbine plant.—*Engineering Magazine (New York), February.*

Economy in Operation of a Mechanical-Draft Plant.

In his work on "Mechanical Draft," J. H. Kinealy states that "It is in the economy in the operation of the plant that a mechanical-draft apparatus really makes its great showing. In the case of a chimney the draft depends upon the height of the chimney, the temperature of the hot gases inside, and the temperature and condition of the air outside of the chimney, while in the case of a mechanical-draft apparatus it depends only upon the power of the motor to run the fan; if a high draft is desired it is run faster and if a low draft is desired it is slowed down. Unless the chimney be built very high the draft produced by it can not be very great and the range of draft therefore can not be great; further, the draft can only obtain its maximum when the fire in the furnace is hot, so as to make the gases in the chimney have a high temperature. In the case of a mechanical-draft apparatus the draft can be increased by speeding up the fan, without regard to the condition of the fire in the furnace. In the case of a chimney the draft can be increased only as the increase in the combustion takes place, and this combustion is due to the draft. The two are dependent upon one another in such a way that it is quite impossible to increase either suddenly. While in the case of the mechanical draft it is possible to suddenly increase the draft irrespective of the condition of either the fire or the draft previously, and this increase in draft is at once followed by an increase in the combustion in the furnace. Again, the temperature of the air outside may have a material effect on the draft of a chimney, while it can not affect at all the draft of a mechanical-draft apparatus And further, the higher draft that can be created by means of the mechanical-draft apparatus enables a poorer grade of coal to be used than could be burned with the chimney draft, and this usually results in a marked reduction in the running expense."

MAGNETIC LEAKAGE AND ITS EFFECT IN ELECTRICAL DESIGN.[1]

BY WILLIAM CRAMP.

It is necessary to divide this subject under the headings of harmful leakage and useful leakage, and again to subdivide it under continuous and alternating current machines respectively. Further, according to the part of the machine we are considering, other subdivisions will be necessary. It is to the useful leakage that I wish to draw in certain cases special attention in this paper. I shall commence, however, with harmful leakage in the field systems of continuous current machines; and at the outset it is clear from the definition given that the coefficient of leakage

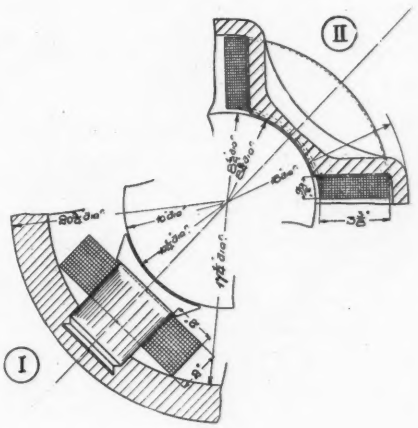


FIG. 1.

will increase with the length of the air gap, and it is also clear that it will increase with the reduction of the length of poles and distance between pole tips. And while it is true that magnetic leakage does not represent a definite loss of power, it is also true that any machine whose leakage can be got rid of will have a distinct increase in output for a given speed; or a decrease in weight for a given output, efficiency and speed. It is therefore of importance that the leakage should be reduced as far as possible.

We note, in the first place, from what has just been said concerning the dimensions of the pole-pieces, that a small magnetic leakage coefficient can be obtained by abnormal increase of armature diameter coupled with decrease of ratio $\frac{\text{pole arc}}{\text{pole-pitch}}$ and lengthened field-pole; which conditions also involve large diameter of field-frame. But reduction of the coefficient by this means only results in a more expensive machine, supposing that the original linear dimensions were settled by sparking and temperature considerations. Further, it is only in certain cases that any improvement at all can be expected. For, consider the following values of the leakage coefficient.

In multipolar machines with normal ratios of pole are: pole-pitch, *i. e.*, an average of .72—the values for the coefficient varies between 1.5 and 1.15 from one kilowatt to 200 kilowatts. Beyond 200 kilowatts the coefficient steadily decreases till we reach 1.1 at 1,000 kilowatts. It is evident, then, that beyond 200 kilowatts the decrease of cost to be obtained by reduction of the dispersion is very small. Let us take a small size of machine, say five kilowatts, and see what improvement can be effected by reducing the leakage. Fig. 1 (I) shows the field-magnet circuit of a machine having four poles, which I designed some time ago to give five kilowatts at 1,000 revolutions per minute. The dispersion coefficient is about 1.35. At high saturations it might become 1.4, and at this figure we will take it. The weight of field copper per spool is 8.22 pounds, and its cross section two inches by two inches.

If the leakage could be reduced to 1.10 the pole area, which is now 9.6 square inches, would become 7.55 square inches and its diameter would be reduced from 3.5 inches to 3.10 inches. This reduces the field copper to 7.77 pounds, and the cost of the total copper by about six per cent, a reduction hardly worth making for its own sake unless other advantages ensue. The question is—can this leakage be decreased without proportionately increasing the amount of field copper or the cost of the frame? In answering this question we notice that to reduce the leakage we must either increase the length of the leakage paths or decrease their area.

In considering the first expedient we have already determined that to apply the remedy of a larger field-frame is inadmissible. Examination shows us at once that the main leakage will take place from pole tip to pole tip. There will be also considerable leakage from pole to pole and also from tip to yoke. The cause of this leakage is the difference of magnetic potential existing between these parts respectively.

Now the leakage path from tip to tip can be reduced by placing the magnetizing coil near the armature, *i. e.*, around the tip itself, and the area of the path between pole and pole can be reduced

[1] From a paper read before the Manchester Section of the Institution of Electrical Engineers, of Great Britain, on January 8.

by shortening the pole, while the area of the path (and its length) can be changed by bringing the sides of the coils upon the respective poles nearer together.

Thus the ideal machine to reduce magnetic leakage to a minimum would be arranged as in Fig. 2, either III or better IV, but, in making the change from Fig. 1 to Fig. 2, we have considerably increased the length of mean turn of the field-coil and some method of compensating for this must be introduced if any economy is to be effected.

This compensation, however, is at once seen to be present from the following table:

TABLE I.

Old Machine: Fig. 1, I.

a. Cylindrical cooling surface—A.
b. Laminated pole-tip to provide and fit.
c. Pole to machine and cast in.
d. Large-diameter frame.
e. Commutation good.
f. Leakage factor, large.

New Machine: Fig. 2, III or IV.

a. Cylindrical cooling surface quite two A.
b. No pole-tip.
c. No machining on pole.
d. Small-diameter frame.
e. Commutation excellent.
f. Leakage factor, small.

The question of commutation requires a word or two of explanation. Good commutation, apart from special devices, entails steady interpolar magnetic distribution. Such distribution is much more marked in machines of Types III and IV than in those of Type I. This is partly to be accounted for by the decrease in leakage and partly by the close proximity of the field-coil to the armature.

We can, therefore, take advantage of the new construction in five ways: (1) Increase the field loss (*a*), thus bringing the weight of copper to the original value and saving, if possible, on *b, c, d.* This is inadvisable owing to the necessarily low rating when enclosed. (2) Let the weight of copper remain, and save, if possible, on *b, c, d.* (3) As the whole machine is likely to keep much cooler, the armature dimensions may be reduced and a saving effected there without practically affecting the efficiency. (4) While, if possible, saving, as in (2) above, increase the overload capacity on account of *e.* (5) Decrease the armature turns in ratio of old to new leakage factor; increase section per turn, and thereby the input.

In applying these possibilities in practice, it has been assumed that the field loss remains about constant, while the length of mean turn is increased from 17.6 inches to twenty-eight inches. Since the resistance of mean turn must be kept constant if the voltage per coil and ampere turns are constant, it follows that a wire of slightly larger diameter is used in the new form. The comparison of one coil of Figs. 1, I, and 2, IV, is as follows:

TABLE II.

	Fig. 2, I.	Fig. 3, IV.
Ampere turns	1725	1725
Length mean turn	17.6″	28″
Current	0.575	0.62
Watts	115	124
Yoke dia	20″	18¼″
Cost of copper (four coils).	36/-	52/-
Cost of steel	16.4/-	13.4/-
Leakage co-efficient	1.35	1.1
Output for given speed	5	6

NOTE.—Fig. 1 has a cast-iron yoke. This in the above table has been reduced to cast steel.

So then the alteration results in a machine of small diameter costing specifically less, yet with better commutation, slightly larger output, better overload capacity both on account of the commutation and the smaller distortion because of the pole shape.

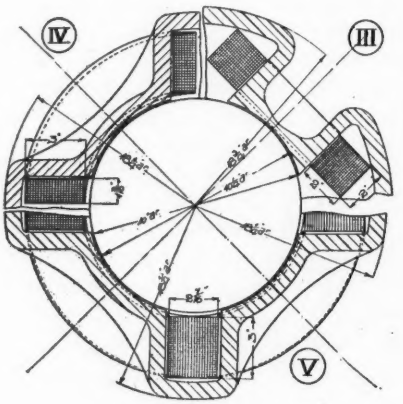


FIG. 2.

In the above comparison little or nothing has been said of the reduced cost of machining Fig. 2, IV, because it may be argued that if lamination is good for the one it is necessary for the other. Fig. 2 is at least as good as Fig. 1 from the enclosing point of view, since its radiation is so much better and its field loss so little increased.

Now in making the above comparison I have changed the original machine without reference to the fact that in so doing we have missed the best proportions for the new machine. The original machine had a round pole which is the best shape. "Round" being out of the question for the new machine, we shall adopt "square" as the next best shape. Keeping then pole area and flux per pole constant we reduce the armature diameter to eight and one-half inches and alter its length to 4.7 inches instead of four inches. The cooling surface is therefore almost the same while the field length of mean turn becomes twenty-six inches instead of twenty-eight inches. All this is shown in Fig. 1, II. Thus a comparison of Fig. 1, I and II yields the following table:

TABLE III.

	Fig. 1, I.	Fig. 1. II.
Ampere turns	1725	1725
Length of mean turn	17.6″	26″
Field watts per cent.	2.3	2.3
Yoke diameter	20.75″	18″
Yoke cost	16.4/-	12.5/-
Field copper cost	36/-	48/-
Total cost (yoke and field copper)	52.4/-	60.5/-
Leakage factor (est.)	1.35	1.1
Output (kw.)	5	6
Shillings per kw	10.5/-	10.08/-

Note that in the above contrast the costs of the two armatures are the same, so that the cost per kilowatt is really far more favorable to Fig. 1, II than appears. From this comparison it is evident that even without considering the reduced cost of machining, Fig. 1, II is the better machine.

These principles should, I think, be applied in machines up to about twenty brake horse-power. Beyond this size the ratio of the cost of active material to labor, together with the small decrease of the leakage coefficient, render the advantages to be gained more doubtful.

Now Fig. 2 immediately suggests the possibility of advantages to be gained by replacing the four original coils by one of zig-zag shape. This is an important point, the more so as several patents have recently been taken out in this direction. They all have for their object what is termed "magnetization of the armature," as against the usual plan of magnetization of the field magnet. The clear meaning of this is that the inventors have aimed either at abolishing magnetic leakage, or else magnetizing the armature, so that the armature itself carries a greater flux than the field poles. This might easily be the case if there is any considerable gap between the wire of the coils and the poles themselves. It also incidentally leads us to discuss the whole question of single field-coil machines.

In approaching this subject we must realize first that the watts dissipated in any coil depend upon the ampere-turns per pole required, the resistance of the mean turn, the number of poles, and the field current. With given voltage across the field and given watts to be dissipated, the field current is fixed, and, of course, the ampere turns per pole are usually also fixed beforehand. Thus the product of the resistance of the mean turn per pole, and the number of poles, will be a con-

stant, and the ampere-turns of the single coil will always have to be equal to those required for one complete magnetic circuit, *i. e.*, twice the ampere-turns per pole. Consequently, as a basis of comparison, if we can show that the length of the mean turn of the single coil is less than the product of half the number of poles and length of mean turn per pole in the ordinary multipolar case, then it will pay to use the single coil, unless indeed it be of such an exceptional shape that the expense of winding it places it out of the question.

In the above machines, Fig. 2, if we substitute a single coil for the four existing coils, it must be of the shape shown in Fig. 3 approximately, and since the centre of its section must correspond with the neutral point between the poles, it follows that its length of mean turn will be sixty-two inches as compared with twice twenty-six or fifty-two inches of Fig. 1, II. It will be obvious that the greater the number of poles, and the shorter the length of the armature, the more likely is the single-coil machine to compete with one with as many coils as poles; but it can rarely be worth while to add poles for the sake of using the single coil, because each pole requires an equal number of ampere-turns, so that usually, from the field point of view, the bipolar is the most economical machine.

speaking the machine easiest to wind and most economical, is that shown in Fig. 1, II. The single-coil machine can be made as economical of copper as this latter form, but only by cutting way alternately on the right hand and on the left the poles of the machine (Fig. 2). This resolves itself into slightly staggered poles with a shoe alternately to right and left, which by slightly increasing the leakage factor does away with some of the advantages of the type. It must be remembered, however, that the provision of shoes upon

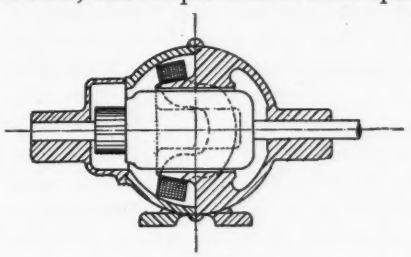


Fig. 3.

the sides of the poles is a very different matter from the use of ordinary pole horns or tips, since it does not increase the leakage factor to anything like the same extent.

Summarizing now the results so far attained:

1. In machines up to twenty horse-power the leakage is sufficiently great to make it worth while to adopt special means to reduce it.

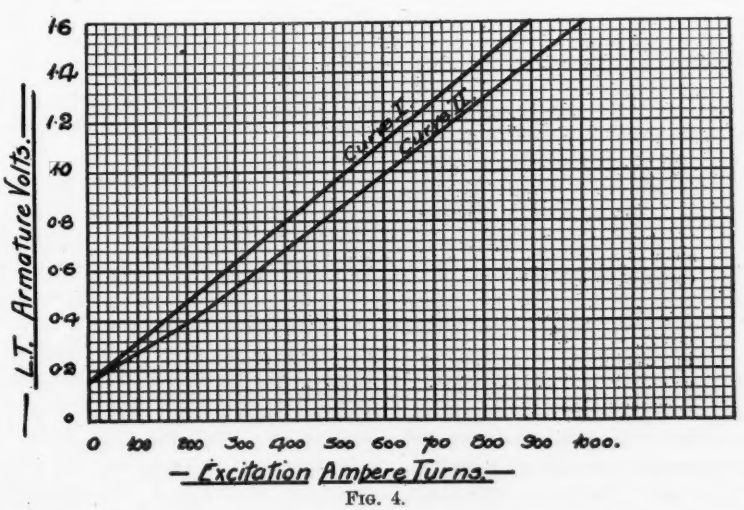


Fig. 4.

I have already touched upon the question of the relative economy of single coil as against multicoil machines. The question turns upon the ratio

$$\frac{\text{Length of mean turn of single coil}}{\text{Length of mean turn per pole} \times \text{pole pairs}}$$

With two poles the single coil is never advantageous, and with four and six poles, very rarely. With more than six poles the single coil may pay, but generally

2. One of the best remedies is the placing of the field coils close to the armature and practically spanning the pole pitch.

3. A single coil may be adopted in place of the usual one coil per pole, but this is not as a rule economical.

4. The single coil will be more economical than the separate coils if the length of mean turn of the single coil is less than the length of mean turn of any one of the separate coils multiplied by half the number of poles.

5. Adopting either of these methods of field winding incidentally reduces both the weight of iron and the cost of the machine, and at the same time improves the commutation.

6. As the general result therefore, smaller machines at a reduced cost can be built for the same output.

Having shown that considerable advantages are to be gained by surrounding the armature closely by its field coils, the logical deduction is that if both field and armature coils are placed upon the armature the results will be better still, since any harmful leakage is then converted into useful leakage. This system, of course, would do away with the field coils proper, altogether, and would resolve itself into the equivalent of an armature and commutator with the brushes set at an angle to the neutral line, which arrangement in the case of the series motor might be adopted, but in the case of the shunt motor we should need two commutators and two sets of coils, with the "field brushes" at right angles to the "armature brushes." Considering first the case of the shunt machine, and remembering that the full voltage must be put across the field brushes, and that the field current will be limited only by the resistance of the coils connected to that commutator, we are at once confronted with the fact that the number of field turns would render such a winding very costly compared with the simple field coils of an ordinary dynamo. Hence from ordinary commercial considerations this variety must be ruled out of the question.

The case of the series motor is different. Here, the field turns will only be about the same as the armature turns, so that it is worth while going into the question to see if any substantial advantage may be gained. From the theoretical point of view, we have two factors to consider.

1. The field coils being distributed about the circumference of the armature will not have along the field brush axis the effect of a concentrated coil producing the same ampere-turns but only about $\frac{2}{\pi}$ times this value.

2. The leakage factor will, so far as mutual induction between the armature and field coils is concerned, be practically unity.

It is evident that the first consideration to some extent discounts the second, so

that we shall not expect to find any value in this type of machine except in special cases. For having placed both field and armature coils on the same member we can make the yoke and poles either exceedingly cheap or exceedingly light. If cheapness is desired, a simple iron casting bored out is all that is necessary; if lightness is desired cast steel may be used, and in either case the magnetic circuit is economical because very short, so that the overall diameter of the machine will, if the armature dimensions are not much increased, be much reduced by the new construction.

In order to put these theories to a practical test I have, with the assistance of Mr. Garner, carried out at the Manchester Municipal School of Technology a series of experiments upon a bipolar double-commutator machine.

The following are its particulars:

Type — Bipolar overtype drum (smooth).

Armature—High tension side 220 volts., 280 conductors. Low tension side twenty volts, twenty-eight conductors.

Field-winding—Each limb twenty-seven layers, 152 turns per layer, .52 inch diameter wire. Resistance forty-five ohms. Total ninety ohms hot.

Output—Two kilowatts.

Leakage coefficient — Calculated by Forbes Lemmae, 1.51.

It will be seen that though from the point of view of leakage, this is an excellent example, yet it is difficult to obtain upon the armature a number of ampere-turns corresponding to that which would normally be upon the field.

The first point of importance is the fact that while the leakage coefficient as calculated is 1.51 we can hardly expect to change this to unity, since part of the leakage is due to the shape of the field, and leakage will take place even when exciting from the armature; also on account of the abnormally low saturations in the test, the coefficient would be reduced.

The second point is the importance of setting the field and armature brushes in such relative positions that the effect of lack of symmetry in the pole horns, etc., is entirely eliminated. This was accomplished as follows:

The machine was driven at constant speed by a small motor, and no excitation being on, both high tension and low tension brushes were moved till they gave their maximum volts (due to residual field magnetism) so that both were upon the neutral line. Since the high-tension brushes were to be used for the field excitation, the low-tension armature brushes were first fixed by choosing such a position that no matter what current was passed through them, the generated volts did not increase, *i. e.*, there was no resultant field at right angles to the low-tension brushes due to their own current. The high-tension brushes were then moved round till they were at right angles to that position where they would give a voltage ratio equal to ratio of turns as compared with the low-tension side.

The normal maximum field ampere-turns are 18,300. This would entail a high-tension current of 260 amperes. The maximum current we could use was thirty-five amperes and this corresponds to 2,450 ampere-turns. Thus the saturation was much lower than usual, and an examination of the magnetization curve showed that we never reached the knee.

The argument used was as follows: The ampere-turns of the high-tension armature acting along the normal field axis will be about $\frac{2}{\pi}$ times those of a concentrated field coil having the same current and turns but placed centrally around the armature between the poles.

1. If then we excite the high-tension armature with a certain current and apply a voltage to the low-tension side, the machine will run as a motor and at a fixed speed the low-tension back volts will be proportional to the flux set up by the field ampere-turns. Now leaving the high-tension armature unexcited, providing on the field coils ampere-turns $\frac{2}{\pi}$ times those of the armature, and measuring the low-tension volts at similar speeds will give us the corresponding flux set up by a corresponding number of field ampere-turns and the ratio of the low-tension volts in the two cases will be the change in the leakage factor produced by the change of position of the exciting coils, provided always that the above ratio $\left(\frac{2}{\pi}\right)$ is correct.

2. Similarly, if instead of using the low-tension armature as a motor armature, we, with similar excitation conditions, drive the machine independently, then the direct ratio of voltages on the low-tension side is the change of leakage factor.

Some of the results of the test are plotted in Fig. 4, and these show the equivalent of a change in the leakage factor from 1.42 to 1.24.

It was thought, however, that this change was really unreasonably small and the ratio $\frac{2}{\pi}$ fell under suspicion. To check this an oscillogram of the flux distribution when exciting from the main fields was taken; and as it was found impossible to obtain a reliable oscillogram when exciting from the armature, the curve for the latter was deduced from the former. This showed that the ratio $\frac{2}{\pi}$ (0.637) was too large and that 0.579 is really much nearer the probable truth. Allowing for this the field ampere-turns should have been decreased in this ratio, so causing the leakage factor (and hence the output) to be changed by twenty-one per cent instead of twelve per cent. That is, by putting the exciting coils on the armature the output would be increased by these amounts. As a matter of fact, however, this is only a portion of the advantage to be gained, for the weight of the field could then be reduced from six hundredweight to about two hundredweight.

There are many points of interest about this research. One of the most interesting is the following:

When the low-tension armature current is considerable, an induced voltage naturally makes its appearance at the field brushes. The direction of the voltage is such as to apparently reduce the current resistance drop at the high-tension brush terminals; or, in other words, the armature cross field becomes in these machines useful leakage and tends to provide the field current. But the most extraordinary thing about it is, that when the speed is eliminated the voltage is found to be constant and quite independent of the armature ampere-turns.

An exact reason for this phenomenon I am unable to furnish, but I think it can only be explained upon the assumption that increase in armature reaction causes the resultant field always to move through such an angle as will cause the horizontal and vertical components to remain constant. Thus increase of the armature current reacts upon the field ampere-turns tending to distort the main field. And this distortion is such that the changed reluctance of the field path changes also the resultant field till the armature component reaches a fixed value, which depends only upon the field frame shape. The same conditions do not obtain when excitation is provided by the field, for then, as would be expected, increase of armature low-tension reaction increases the high-tension volts per revolution per minute.

Another point which is full of suggestive interest is the fact that rotation

of the armature in the field set up by the armature current produces an electromotive force at the field brushes assisting the field current. This is, of course, equivalent to saying that, if the field brushes were short-circuited, they would of their own accord by rotation of the armature in the armature field set up a field current magnetizing in the proper direction. But this is the very essence of modern compensated alternating-current motors, and to students and teachers alike forms a most valuable starting point for the study of such machines.

The foregoing tests, though conclusive evidence that in the machine actually tested the saving everywhere by adopting armature and field coils placed on one member is enormous, form hardly a just criterion. For in fairness it should be stated that the type of machine is old, and though the saving over modern machines might be considerable, it could not be of the same magnitude as in this case. To take, therefore, a more up-to-date instance we may use the machine already shown in Fig. 1, I. If this machine, with a standard armature winding, be used as a series motor without field coils, then when its brushes are inclined at an angle of forty-five degrees to the neutral line, its output is less than one-half of its previous power. There are two points, however, that must not be overlooked; one is the fact that if the machine is designed on these lines for use as a series motor, a different length of armature can be used, giving us rather better results than those quoted. The other is, that by altering the angle at which the brushes are inclined the field and armature ampere-turns can be adjusted, giving us a large control by very simple means. The effect of such change is to give variable torque with practically constant speed; for if a sinusoidal distribution be assumed for field and armature, moving the brushes through an angle of θ from the field axis changes the field effective ampere-turns according to cos θ and the armature effective turns according to sin θ so that the torque, which is proportional to the product of these two, is a maximum at θ equal forty-five degrees.

Corresponding to every position of the brushes the motor has a definite characteristic; when the brush axis nearly corresponds with the field axis the characteristic is that of a series motor with a strong field and weak armature, while the reverse is the case if the brush axis approaches a position at right angles to the field axis. Thus while maximum torque exists when θ equals forty-five degrees, increasing θ beyond this value will cause the armature active turns to increase and the field ampere-turns to fall, so that the speed should remain about constant, the torque being slightly reduced.

In practice, however, such sinusoidal distributions never are found. If as is usual, the field-poles subtend an angle of 135 degrees, upon moving the brushes from $\theta = 45$ degrees to $\theta = 67$ degrees the area of the effective air gap increases though the field ampere-turns fall, and meanwhile the armature turns increase; thus the total field over this range will remain nearly constant so that the torque (which depends upon the average air gap flux density and the number of conductors carrying current immersed therein) will not sensibly increase, but the back electromotive force (which depends on the total field flux and the number of armature active conductors) will increase for a given speed. Over this range then, the motor acts as a shunt motor with a variable resistance in its armature circuit. Outside this range it behaves as described above.

It must not be forgotten that such a motor will need a larger commutator and smaller reactance voltage than the ordinary series motor, and this fact, together with the characteristics already given, combine to show that only in special cases will it be of commercial value.

These cases are such as would necessitate a machine having extremely small external dimensions with no room for series rheostat or similar means of control, and an example is the small electric runabout. Even here its use is a little doubtful, because with cells, variable voltage control can be so easily and cheaply arranged. Indeed for small motors it is hard in my opinion to beat Fig. 1, II. But very long motors of very small diameter might be better, if arranged without field coils.

(To be continued.)

Safety of Electrical Systems.

To the Editor of the Electrical Review:

Referring to the article on the "Safety of Electrical Systems" on page 172 of your issue of February 2, I would call your attention to the fact that the Massachusetts Gas and Electric Light Commission publishes annually a list of the accidents from electricity.

The copy that I have at hand is for 1904, during which year there were five fatal accidents from electricity, all of which occurred to workmen in the electrical works, or to linemen on poles. There were seven non-fatal accidents, of which only two were to users of electricity, the other five being to the workmen.

Comparing these with the accidents from gas, we find that during the same year there were seventy-four fatal accidents, and 109 non-fatal accidents from gas to users of gas.

I have not the railroad figures at hand, but from those I have recently seen in the daily papers, railroad accidents are greater than either gas or electricity.

The official figures for electrical accidents show that the danger is absolutely nominal, compared with the results in other trades. R. S. Hale.

Boston, Mass., February 4.

The Electrical Behavior of the Allotropic Modifications of Selenium Under the Influence of Heat and Light.

Researches into the effect of heat and light on the various allotropic modifications of selenium have been made by P. v. Schrott. The forms studied were obtained by chemical methods from potassium selenide, this being in the gray crystalline condition, and also the red crystals deposited from carbon bisulphide and the amorphous red selenium obtained by long standing in chinoline. These different modifications of the selenium were pulverized and pressed into cylindrical forms, and their electrical properties investigated. When the pressure was great—about 10,000 kilogrammes per square centimetre—the red precipitated selenium went over into the black vitreous form. All of the amorphous forms obtained from the gray crystalline preparation by heating were exceedingly variable, showing sometimes positive and sometimes negative temperature coefficients of resistance. The exact differences made by Siemens between the three modifications, designated as one, two and three, were not observed, as the various forms seemed to merge. The hard and the white selenium described by Ruhmer resemble Siemen's forms one and two. It was found that the crystallized selenium obtained from potassium selenide was not a conductor and was not sensitive to light. This is the base of the gray crystallized selenium which is stable at ordinary temperatures. Through heating this goes over partly into metallic selenium, which is an electrical conductor, and is sensitive to light without heating. The form of selenium crystallized out of carbon bisulphide tends to go over into the metallic form if heated. The sensitiveness to light of the latter form of selenium is not affected by temperature until in the neighborhood of the melting point, which is 210 degrees centigrade. After reaching this point and cooling, the resistance increase due to the effect of light is about seventy per cent. The results of the investigation are not in agreement with the explanation of the effect of light as given by Siemens and Hesehus. The author attributes a decrease in the resistance due to light to ionization, while an increase in the resistance is thought to be due to photopolymerization.—*Translated and abstracted from Physikalische Zeitschrift (Leipsic), January* 15.

HIGH-VOLTAGE CONDENSERS.

BY C. L. DURAND.

The defects found in the usual types of condensers are of three kinds: first, a low resistance to the breaking down of the dielectric; second, the coatings are not in intimate contact with the dielectric over its whole surface; third, the cooling is generally insufficient. All the condensers whose dielectrics are formed by organic matter such as paper, cloth, etc., are to be rejected, for these substances disaggregate with time and on account of the electrolysis of the interposed liquids. In the course of numerous tests upon condensers made by different companies, M. Moscicki perceived that the breakdown occurred nearly always at the border of the plates. The experiments showed, for instance, that a sheet of glass five millimetres thick can support in the middle part a pressure as high as 67,000 volts

FIG. 1.—ELEMENT OF CONDENSER.

while in the parts near the edges the coatings are perforated at a tension of 11,700 volts. It is also found that any foreign body placed between the dielectric and the coatings gave a point which caused the breakdown of the condenser. Hence it is essential that the dielectric and the coatings be intimately superposed over their whole extent.

In order to avoid these faults, the inventor made the elements of his condensers of glass tubes T (Fig. 1) whose neck C has two or three times the thickness of the rest of the tube. The latter is covered inside and out by a chemical silvering process and this very thin layer of silver is coated with a thicker layer of copper which gives the needed strength. Thus the edge of the outer coating, or the weak part, is exactly at the point where the dielectric is reenforced, and it results that these elements have the same resistance to puncture as if the tube had everywhere the same thickness as the neck, while their capacity will be determined by the thickness of the lower or thin part. If the precautions which are learned by practice are observed, the layer of silver will be exactly superposed upon the sides of the tube without introducing any foreign body

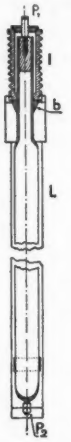


FIG. 2.—ELEMENT OF CONDENSER.

or layers of gas. Thus the above-mentioned faults will be avoided. Each of the tubes (Fig. 2) is provided with an upper contact P_1 connected with the inside coating and a lower contact P_2 joined to the outer coating. The neck of the tubes is sealed in an insulator I with grooves, which gives a good insulation between the coatings. The glass tube is placed in a sheet-iron tube L whose tight closing is assured by a cap in which is placed a conical rubber stopper *b*, and the porcelain insulator is provided with a bayonet joint which presses upon the stopper. The contact of the outer coating is connected to the metal tube. Glycerine is filled in between the metal and glass tubes, mixed with distilled water. This method of mounting gives new advantages, seeing that the liquid by distributing the heat through the whole mass prevents local heating which would bring about the breakdown of the element. Moreover, in place of having the copper for the radiating coat, we have the surface of the metal tube, which is blackened. The accompanying illustrations show several groups of these high-voltage condenser elements.

These elements are used generally for tensions of 10,000 and 15,000 volts, and are tested at 27,000 and 40,000 volts. For higher tensions they are connected in series, and thus are secured batteries working at 100,000 volts. Each element of a battery is provided with a fuse wire which cuts it out in case of accident, leaving the other tubes working.

One advantage of the use of condensers is in the suppression of phase lag and phenomena of resonance. Central station operators are aware of the complications which are brought about by the fall in voltage of the alternators. If a group is to give, for instance, 100 amperes with a power-factor of 0.85, not only will it furnish fifteen per cent less energy than if the power-factor were equal to unity, but it requires about twice the exciting current. It is not excessive to say that if a central station was assured of always working without lag, it could install alternators costing twenty or twenty-five per cent less, or with the same machines give one-fifth or one-quarter more power. This is not the only disadvantage of giving wattless current to the line. It often happens that the day load is used mostly for running empty transformers, whence the

SET OF SIX CONDENSERS.

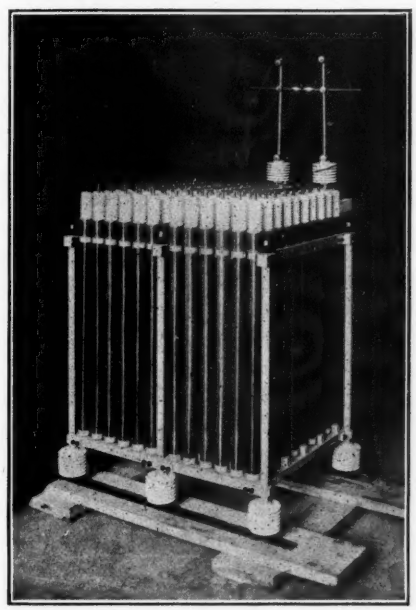
large amount of current needed and large machines set in action with but light load. Outside the coal expense, we have oiling and labor, which is about the same as for full load.

Wattless current produced under the best conditions is what has been sought for by engineers for a long time, so that only the machines which are required for the real power need be run, but up to the present the solution is not at hand. Condensers are the inevitable solution of the problem, provided they can be made commercially available.

Suppression of harmonics is another feature. Many alternators have voltage and current curves containing harmonics, sometimes as high as the fifteenth. They may give dangerous phenomena of resonance, and are harmful for motor working and especially for rotaries. When there are capacities in series with the line these

harmonics have a tendency to increase and this as their order is higher. Often differences of potential are found at certain points of the network which are out of proportion to the machine voltage. With capacities in shunt, on the contrary, these harmonics are lessened, for they are short-circuited by the capacity and in proportion as their order is higher. The third harmonic will pass into the battery of condensers three times as easily as the first, the fifth five times, and the fifteenth fifteen times and so on. Thus the current given to the line will be more nearly a sinusoid than before.

Operation of switches is not without danger on a system, as, when opened, a switch forms a more or less perfect os-



BATTERY OF CONDENSERS.

cillatory device and when the current breaks it creates a series of oscillations whose frequency may be 6,000 or 8,000 cycles. These are very dangerous and cause many accidents to machines. It is evident that by placing a set of condensers on the machine when the frequency of 8,000 is produced, this will pass through the battery sixty times as easily as the standard fifty-cycle current. Take the case of a 2,500-kilowatt battery in a station giving 5,000 kilowatts, the current passing the battery at 5,000 volts is 500 amperes. With 8,000 cycles, it can reach 160 times this or 80,000 amperes at 5,000 volts. That is, the machine is practically put on short-circuit for all the high-frequency currents. The condensers also protect the alternator from atmospheric discharges of an oscillatory nature by connecting the middle of the battery to ground. As the atmospheric discharges have a very high frequency (500,000 to 1,000,000), the short-circuit to ground is almost absolute. In the preceding case, with a potential of 2,500 volts to ground and fifty cycles, making a current value in the battery of 500 amperes, with a frequency of 500,000, there would be 5,000,000 amperes passing without causing the voltage to rise above the standard.

The condensers are used to advantage for suppressing the extra currents which often damage the railway motors. Each time the trolley leaves the wire or the wheel leaves the rail, resonance phenomena and high-frequency currents are produced. It is found that the rise in voltage coming from this cause can reach, and even exceed, 5,000 volts, which may break down the insulation. To avoid this, it is planned to place in the motor circuit a large choke coil and to short-circuit the motors by condensers. Other sets of condensers, which are fixed, connect the line to ground at intervals. All the currents of high frequency produced by the interruptions pass by the condensers without damaging the motors.

Starting of induction motors on single-phase current is another point where condensers can be well used. Certain types of induction motor do not start up under load, and even using methods which allow them to start at no load, the couple is small. With condensers a motor of the usual three-phase type may be supplied from a single-phase current and secure the same conditions of working as if it were supplied with three-phase currents. If the motor has a sufficient voltage (5,000 or over) the condenser is connected directly across one phase. For lower voltages it is connected through a step-up transformer. An inductive coil is connected across on the other phases in each case. In all cases the battery of condensers and the choke coil should have a power equal to sixty per cent of what the motor requires. The armatures of the three-phase motors should contain starting resistance, otherwise the capacity of the battery needs to be two or two and one-half times greater to give the maximum starting couple.

Protection of lines from atmospheric discharges is well effected by means of these condensers. As these have a very high frequency, they may be carried to ground without allowing the low-frequency alternator current to pass. The principle used is based on the fact that the current through a condenser is proportional not only to the difference of potential between the two coatings but also to the frequency of the alternator. Taking a set of condensers which will let flow to ground with the standard voltage and fifty cycles, a current of 0.1 ampere, the same battery will let pass 1,000 amperes at a frequency of 500,000 without needing a higher tension. Atmospheric discharges are of this order, and the flow to ground can be very high without having the line voltage exceed the standard.

Medal Awarded at the First International Exposition of Safety Devices.

The first international exposition of safety devices, under the auspices of the American Institute of Social Service, held at the Museum of Natural History, New York city, from January 29 to February 12, attracted very general attention and it is expected that the auspicious circumstances surrounding this inaugural exhibition will establish the permanency of the idea.

Appliances for safeguarding the lives of operatives manipulating machinery of

MEDAL COMMEMORATIVE OF THE FIRST INTERNATIONAL EXPOSITION OF SAFETY DEVICES, HELD AT NEW YORK CITY, JANUARY 28—FEBRUARY 12.

all types were gathered from all parts of the civilized world, a number of prominent manufacturers contributing interesting devices which have been worked out in factory operations.

The accompanying illustration is a reproduction of a medal which has been struck in commemoration of this first exposition and which has been awarded to those taking part in the demonstration.

The Iowa Electrical Association.

The Iowa Electrical Association, representing the electric lighting interests of the state, and the Iowa Street and Interurban Railway Association will meet in Clinton in annual convention April 18, 19 and 20. The managers and other representatives of nearly all of the electric light and railway associations in the state will be in attendance, and it is expected that 400 men from Iowa cities and towns will be there.

REVIEWS OF CURRENT ENGINEERING AND SCIENTIFIC LITERATURE

The Telephone Relay.

M. Henry reviews here the various attempts that have been made to construct a satisfactory telephone relay, and comes to the conclusion that but one of the plans proposed promises well. This plan contemplates the use of the telephonic currents as the exciting currents of a small dynamo driven at a constant speed. The variations in these currents will be followed by corresponding field variations, and consequently will induce corresponding variations in the electromotive force generated in the dynamo armature. There are a number of difficulties to be overcome, and the author has not yet been able to make any satisfactory experiments. This method would introduce an electromagnetic reaction in place of the effects of inertia and mechanical resonance encountered in other types of relay, but it is thought that the reaction can be met successfully. The method is thought to be suitable for other purposes, such as transmitting pictures and observing electrical phenomena of earth and air.—*Translated and abstracted from L'Électricien (Paris), January* 19.

A Spectrum of Roentgen Rays from a Focus Tube, and the Relatively Selective Absorption of Roentgen Rays in Certain Metals.

The experiment described here was made by J. M. Adams to determine whether an ordinary beam of Roentgen rays is heterogeneous, if substances show selective absorption toward the different kinds of rays; furthermore, to ascertain whether the selective absorption, if it exist, follows the same law for all substances. To carry out the test a Roentgen ray tube similar to an ordinary focus tube was prepared, except that the target consisted of a strip of platinum bent to a circular arc and placed in the tube. A thick lead screen was set up in front of the tube facing the concave side of the target in a plane parallel to the axis of the tube. At a point opposite the target this screen was pierced by a small hole with beveled edge. When the tube was in operation a bright spot was observed on a fluorescent screen placed behind the lead screen, this being the image of the spot on the target. A magnetic field was then applied to the tube, so that the ray striking the target was spread out into a spectrum. The effect was to draw out the spot on the fluorescent screen into a band. It was to be expected that the rays at different points along this band would show different properties. That a more or less complete separation of Roentgen rays into a spectrum was actually effected was made plain by dividing the band into halves lengthwise and photographing it while one-half was covered with a sheet of copper. The photograph thus obtained showed that the absorbing power of copper at the two ends of the band was different. By covering the two sides of the band with different metals and photographing it the result showed that the metals have different absorbing powers. It was shown in this way that certain portions of the band were transmitted through some metals, such as silver, in much greater quantity than through aluminum, and that this result was not affected by the thickness of the plate. The conclusions drawn from the experiment are that the beam of Roentgen rays from a focus tube is heterogeneous; that a metallic sheet shows selective absorptions of the above rays, and that this selective absorption does not follow the same law in all metals.—*Abstracted from the American Journal of Science (New Haven, Ct.), February.*

Traction Dynamics.

The factors entering into the propulsion of cars by means of electric motors are considered here by E. G. Allen. The general effects of poor track and wind resistance are pointed out. For city and suburban work, where a speed of thirty miles per hour is not exceeded, it is safe to assume that the train resistance is twenty pounds per ton. For high-speed interurban calculations the resistance varies with the speed, as the wind effect must be taken into consideration. The loss of energy through braking is variable and largely affected by conditions of schedule and grade. For a certain class of service the amount of braking is almost solely responsible for the widely different number of watt-hours necessary for each ton-mile of car travel. It is therefore important that schedules, gear ratio, grades, etc., should be selected, as far as feasible, with a view to reducing the amount of braking necessary. Steep grades increase the loss of energy through braking. Examples are given showing that this increase may be from five to ten per cent. The schedule has an important bearing on the power consumption. With an easy schedule much drifting may be introduced into the car movement and braking be begun at a lower speed, so that less energy will be lost from this cause. A decrease in schedule speed of twelve per cent in one case brought about a decrease of nearly fifty per cent in the energy consumed by the car. When a car is obliged to accelerate frequently and does not run any great distance at its maximum speed it is best to use as low speed gears as possible and allow the required schedule to be made with ease. This is desirable for the equipment and for the power station, as the starting current is light. It gives minimum losses. The line voltage has an effect on power consumption dependent on other conditions. If no attempt is made to hold the schedule and the proportion of coasting is maintained, a decrease in line voltage decreases the watt-hours consumed per car mile on account of the decrease in motor and rheostat losses due to increase in current value and decrease in train resistance losses due to decrease in speed. If, on the other hand, an attempt be made to maintain the schedule speed with low voltage, the power consumption may be increased even above normal. Rates of acceleration affect the power consumption, for with more rapid rates more ground is covered during periods of acceleration and more coasting may thereby be introduced. Increase in acceleration is obtained, however, at the expense of increased currents, which tend to overload the motor and increase motor and rheostat losses. The number of passengers carried on a car affects the power consumption somewhat, partly on account of additional weight, but chiefly because of the increase in the number and length of stops. Theoretically with no braking losses the power consumption in watt-hours per ton-mile should be numerically twice the train resistance expressed in pounds per ton. Expressions for the theoretical loss in braking may also be worked out. These values are good and valuable as a matter of comparison and as a guide, but the

results given by them are lower than those obtained in actual operations, on account of various factors which can not be given consideration in the formulæ. A factor which is as important, if not more so, than the watt-hour consumption, is the maximum power demand of a car or system, as it is this which determines the number of feeders required and the size of the generating or converting apparatus. A large system ordinarily gives a daily load factor of from thirty-five to forty per cent; for a small system it may be as low as ten per cent.—*Abstracted from the Journal of Electricity, Power and Gas (San Francisco), January* 12.

Radium and Geology.

When considering the influence of radium on earth history, it is generally assumed that the radium detected everywhere in the surface materials of the earth is an original constituent of the igneous rocks. A recent study of the matter has led J. Joly to a different view, as there seem to be difficulties in the way of accepting the original or primary nature of the radium in rocks. The original nature of the radium can not be maintained without at the same time assuming the presence of the associated uranium to make good the radioactive decay. If such uranium existed difficulties arise from the facts of solvent denudation. The ocean receives the dissolved rock materials, and even assuming geological time as only a very few million years, according to this explanation the quantity of radium now in the ocean should be much greater than has been observed. If the river supply of dissolved rock materials had been sustained for only 20,000,000 years, sea salt should possess a richness twenty-five times as great as the ascertained amount. In making this statement it is assumed that the radioactive substances are removed from the land along with other mineral matter, and that along with the radium brought into river water on the breakup of rock minerals the postulated uranium is also carried to the ocean. R. J. Strutt has estimated that the radium in sea salt is 0.15×10^{12} gramme per gramme. From this there must be in the ocean about 8×10^{9} grammes. From Boltwood's experiments, to maintain this quantity of radium in the ocean there must be brought into it annually 1.78×10^{6} grammes of radium. Taking the accepted figures for the total volume of river water and the dissolved matter therein which annually enter the ocean, and assuming that the matter in solution possesses the mean radium content of the igneous rocks, it is found that only 10^{4} grammes should enter the ocean annually in the waste of the land. This is not nearly what is required to maintain the oceanic radium at its approximate present value. If the associated uranium enters along with the radium there would be in 800,000 years an accumulation of uranium in the ocean sufficient to account for the existing amount of radium; but evidently this period is too short geologically. For these reasons the author seeks to explain the presence of radium in other ways. The simplest explanation is that there is no associated uranium generally distributed throughout the surface materials of the earth. Exception, of course, must be made to the ore bodies and thermal springs and to certain igneous masses which contain uranium. The radium can not come from volcanic sources, nor can it reach the surface as ores in general do by means of fissure veins. By a process of exclusion the author thinks that he is justified in considering the possibility that the radium is picked up by the earth in its motion through space. The probable source of it is the sun, and there are arguments in support of this view besides that of exclusion. The radium is fairly uniformly distributed over the earth's surface, and it would be expected that the more impervious mineral substances would show the least amount, as has been found to be the case by Strutt. There appears to be no improbability that matter in minute quantities might reach us from the sun, and here we are observing the most minute traces. If the observations are correct as to the velocities of solar ejections, it would take but a few days to bring solar matter into the orbit of the earth. Sun-spot weather action may also be involved, as well as the phenomena of atmospheric radioactivity.—*Abstracted from Nature (London), January* 24.

Hard-Drawn Copper Wire.

Although hard-drawn copper wire has been defined as wire which will not elongate more than one per cent without fracture, this definition is not applicable to the conditions of practical testing. In the case of soft copper wire under stress a steady, permanent elongation takes place, as the load is increased, practically throughout the length of the piece under test until the breaking point is reached, when a local elongation takes place at the spot where the wire breaks. The total elongation being large, this local elongation is small in proportion, and so the result is not materially affected by the length of the test piece. With hard-drawn wire the actual increase of length while under stress is small until the point of fracture is reached, when a local elongation takes place which forms a large part of the total; consequently, if elongation is measured up to actual fracture, the percentage depends through this cause alone largely on the length of the test piece. The test pieces usually employed are not more than eight or ten inches long, and the total elongation to be measured is small; therefore, although fairly uniform measurements may be obtained, the readings are largely affected by unavoidable sources of error, and are a good deal higher than they should be, as much smaller figures are obtained by careful experiment from pieces many feet in length. The effect of drawing upon copper appears to be twofold; it increases the tensile strength and increases the elasticity. The latter effect is almost nullified by subsequent annealing, the former effect partially so. The action appears to be to some extent superficial, as the effect is less on a wire of large diameter than on one of small diameter. It is customary to draw each size of wire to such an extent as shall give ample strength for the purpose for which it is employed without increasing the cost of the thicker sizes to an extent which would not be warranted by the slight increase of strength obtained. Diagrams are given showing the gradual alteration of the behavior of the wires under tensile stress, from wires one-half inch in diameter to eighty mils. The latter wire has an ultimate strength of thirty tons per square inch, while for the former it is only 22.4 tons. The elongation at fracture rises from 2.2 per cent in ten inches for the smaller wire to three inches for the latter. The elastic limit follows the breaking stress in a fairly constant ratio, being reached on the thinner wire at seventy per cent of the breaking stress, and at seventy-five per cent for the thicker. In preference to a test for elongation the author prefers the specification called for by the British post-office. This says that all wire shall stand wrapping in six turns around its own diameter, unwrapping and wrapping again in the same direction without fracture. This, if coupled with the requirement of a sufficient tensile strength, ensures wire of the best possible quality for all overhead purposes. A graphic diagram is given for showing the variation in tensile strength throughout the range of sizes. This line follows closely the line determined experimentally with a margin of about one-half ton per square inch.—*Abstracted from the Electrical Review (London), January* 25.

Methods of Getting New Business

A DEPARTMENT DEVOTED to the COMMERCIAL DEVELOPMENT of CENTRAL STATIONS

Managers are Invited to Contribute Suggestions for Methods of Increasing the Demand for Electric Service

EDITED BY CHARLES A. PARKER.

The Cost of a Grouchy Telephone Clerk.

If you have the colossal, dazzling effrontery to doubt the all-around purity, probity and perspicacity of the average telephone clerk, ask him about it.

That he is a power in the central station's down-town office is no mooted question—in his mind, at least. The president or manager may hold a position slightly greater in importance than his, but you can't make a certain few of his genus believe it. And when it comes to condescending to use courteous language to mere customers, who call up by telephone for information, such an attitude would too often shame, belittle and plebeianize him.

Don't misinterpret us—all telephone clerks are not members of this superior species—all are not tarred with the same brush. But as a class, the public has been forced, by sore experience, to regard the usual telephone clerk as a necessary evil that must, perforce, be tolerated. As a matter of fact, the telephone clerk often forms the only connective communicating link between the largest part of the public and the central station company.

A great part of the people go on for years using electricity, and never get beyond the telephone stage in their personal relations with the company. It is therefore but natural that they should be prone to judge the company by the treatment they receive through the telephone.

In this important department for good or evil, pray, how are you equipped? Is this department in your business presided over by one of these self-inspired, short-mannered, irritating personages? Is he spreading broadcast among your people a wrong impression of the spirit of your company? Is he sowing the seeds of rancor in those with whom he talks through the telephone. Is he giving you a reputation for discourtesy and lack of consideration toward your people?

It is one of the unexplained mysteries of life that when an individual begins to be a buyer—a patron—he immediately conceives it is his duty to become notional, and find fault. No matter how fair-minded he may be in other respects, the fact that he is a customer impresses him, somehow or another, with a feeling of testiness, and a realization that he is a being expressly to be catered to. This seems to be an inherent characteristic of all human nature. It may not be just, but it is a condition which the public service corporation, particularly, seems to be looked to to recognize.

Mrs. Brown pays her monthly bill for current, and on the heels of it telephones the central company regarding some grievance she has discovered or imagined, it makes no difference which.

Right here is presented a splendid opportunity for your telephone clerk to show his real worth. If he turns Mrs. Brown away with a short or unsatisfying or irritating answer, the chances are that Mrs. Brown will feel aggrieved, imagine she has been "bitten off," and the memory of the discourtesy will gnaw at her inner being to the extent that she will conjure up and magnify all manners of grievances against your company, and tell others the story.

And so it lies within the province of the telephone clerk to poison the mind of a valued customer, and put her into the wrong channel of thinking things.

What can we do with such telephone clerks? Quite a lot, if you please. The manager of the central station plant is a pretty busy fellow, who can find little time to play, yet he could well afford to keep an eye on his telephone clerk. By taking a personal interest in the telephone department for a time, he could, with proper effort, convert his telephone clerk from a disquieting and business-destroying medium into a business-builder. Let him thoroughly impress upon his clerk the importance of courtesy to whomsoever may call up—patron or no. Let him understand that it is not sufficient that the man at the telephone should politely answer a question over the telephone. It behooves him to do more than that.

If the question happens to be something he can not answer at the moment, let him show enough interest in his job to procure the name and address of the questioner and respectfully inform him that the matter shall have prompt attention from the

Handsome bulletins published in connection with the very forceful campaign of direct-by-mail advertising now being carried on by the Mexican Light and Power Company, Mexico City.

proper source. Let the telephone clerk also bear in mind that such matters as these may be handled by him in such a way through the telephone that the person at the other end will not be made to feel that he has intruded, and that his complaint is going to be investigated simply as a matter of forced duty by the central company.

On the other hand, a tactful, pleasant-mannered, willing clerk can so treat these cases that the complainant shall be disarmed of all pugnaciousness and made to feel that the company really has his interests at heart, and is not only willing, but anxious, to straighten out any troubles that may exist. And thus, in place of offending and perhaps losing a customer, a more valuable customer than even before is made for the company.

The average man is flattered by attention. It's a trait that few of us outgrow. And, as before hinted, the man who considers himself a customer wants a lot of attention. Sometimes he contrives to stand around in the way, secretly hoping that he may get bumped and thus have an excuse to get mad and find fault. This shows one of the common weaknesses of human nature, which all merchants who sell things must contend with.

The central station company is particularly subject to this condition, for the reason that most folks look upon any public service institution as a selfish, grasping sort of ogre, with a pulse beat at seventy, a temperature at zero and a taunting grin at the great public's complaints.

Young man, if you are a telephone clerk, you can be a better telephone clerk. Do not be content to answer your telephone in a listless, perfunctory way. Put your heart in your employer's business. Take an interest in the wants of your employer's patrons. They are deserving of your best efforts, through the telephone. In serving them you are serving your company, and whatever you may accomplish toward a development of a friendlier relation between these patrons and your company must, in the end, react to your own individual good in the way of earned promotion. Strive to make yourself too conspicuously big for your position. Don't be content to work for six o'clock and six dollars. It is possible for you to make yourself known and felt by your treatment of customers through the telephone. And it is possible that your employer will be the first to recognize your efforts to promote the general good.

The Grand Rapids Edison Company improved the opportunity to become acquainted with its public by making a very attractive and complete exhibit at a pure food show held in its city. It is reported that public interest in many of the new electrical devices was greatly stimulated by this action on the company's part.

We thank you for the remittance covered by the enclosed receipts.

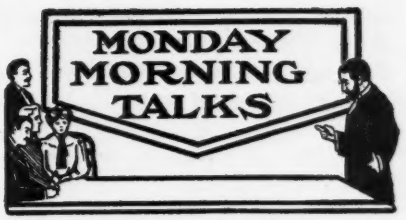
We hope to merit your continued patronage by making our service the best in the world.

Will you help us by promptly telling us of any difficulty you may experience with it?

Peoria Gas and Electric Company.

PHONE MAIN 3340.

An excellent example of a receipt blank card, sent out by the Peoria Gas and Electric Company, Peoria, Ill., and which serves to illustrate the new public-befriending tone adopted by the more commercially aggressive central stations throughout the United States.



Under this general heading we shall present to our readers a series of bright, stimulating talks to solicitors, which, we believe, will prove valuable to managers of new-business departments in suggesting points which they can profitably bring out in their occasional meetings with the company's representatives.

We shall gratefully accept contributions and suggestions from any of our readers.

This is the best and brightest time of the year for our business.

What have you done toward making a good start and getting your share?

How are you going to stand when the list of sales is made up at the end of the month? The opportunities are all around you for the lining up of new prospects, new business, but they won't come unless you dig—dig deep for them.

Down below the outer crust of threshed-over prospects is the hard-headed man who will be interested if a good proposition is put up to him in a real, live, convincing way.

Mind you! no half-hearted attempts will go. You've got to get out your best brand of selling arguments and shoot a line of convincing and interesting ideas to help his business.

That's what this man wants to know—will it help me and can I make it pay in my business?

But you've got to dig for these fellows for the same reason that you have to dig for gold. The biggest nuggets are generally anchored the fastest in the earth and it takes the hard digging to loosen them.

The best contracts generally require the most digging, but they pay us for our hard work.

Don't wait for something to turn up—there's a contract waiting for you somewhere, but you've got to go after it—it won't come to you.

Why not start your search to-day?

Why not bring in the business we know you are capable of if you go at it in the right way?

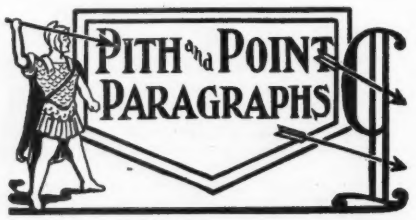
We want you to have a big balance to your credit on the right side of the ledger this month, partly because we want this month's business to be a record breaker and partly because we are both in the business to make money, and what we make must be made together.

Why not get the right start now and bag those orders that mean business for us now and in the future?

Don't spar for wind—don't promise

yourself that to-morrow you'll get really and truly busy, but start to-day.

Hit those prospects you meet like a landslide and carry them off their feet. Then keep up the work the rest of this month and you'll have a good start toward making this year your best.



Under this heading we shall, from week to week, present to our readers a little series of inspirational aphorisms (original, aboriginal and selected), which will, we believe, prove stimulating and suggestive to those who are interested directly or indirectly in the sale of central station current.

A business not advertised is a business without a chance.

Good nature without prudence is foolishness.

Don't use "the best in the world"—it is empty bombast.

When a man loses he blames it on his luck; but when he wins he attributes it to his good judgment.

Keep your idea box open for contributions at all hours.

Make electricity talk economy—an argument to the purse listens best.

Signs of the times are electric signs.

Fire most ammunition where your rivals are thickest.

Get to-morrow out of your vocabulary.

Talk like a sensible man—not like a parrot.

You will get closer to a man by letting him do you a favor than by doing him one.

Don't wiggle.

Here's a tip—dig, push, sweat—but get the contract.

The great hindrance to all motion is friction, yet without friction there would be no motion.

Do not crowd electricity upon a man, but do not err in the other direction either.

A solicitor will succeed with those to whom he makes himself agreeable.

A million mice nibble at every business concern. Keep the traps all set.

Your opportunity is a gold mine—it gives you a chance to dig, dig, dig!

A solicitor looking for sympathy needs only two swift kicks, properly placed.

A dozen adjectives are outweighed by one fact.

The best solicitor is a talker, a thinker and a man of the people.

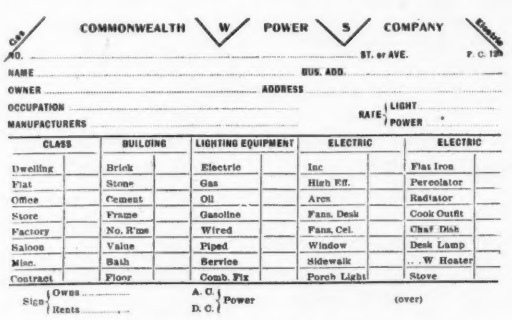
It will be our endeavor, from week to week, to present in this department brief notices of activities among the central stations, as gathered from men who are in the field and, consequently, in close touch with the progress of the new-business idea and its acceptance by central station managers. Contributions to this department are solicited, and will be received with much appreciation by the editor.

If you are doing something a little better than or different from the other fellows, and think it would make interesting reading to ELECTRICAL REVIEW readers, send in your schemes and plans. They will be gladly received.

Address all communications to Charles A. Parker, care of the ELECTRICAL REVIEW.

Port Huron Light and Power Company, Port Huron, Mich.—Among the younger and progressive central station managers we are pleased to say that A. Marshall, of Port Huron, Mich., is more than "making good" with his modern and up-to-date methods of going after business.

On January 1, 1906, the Port Huron Light and Power Company made a sweeping reduction in rates, depending entirely upon the increased use of current for its revenue. Mr. Marshall informs us that one month after the reduction in the cost of current the revenue was about the same and has increased each month considerably, so that at the end of the year 1906 there was a fifteen per cent increase.


COMMONWEALTH W POWER S COMPANY

NO. ..... ST. or AVE. .....

NAME ..... BUS. ADD. .....

OWNER ..... ADDRESS .....

OCCUPATION .....

MANUFACTURERS ..... RATE { LIGHT ..... POWER .....

CLASS		BUILDING		LIGHTING EQUIPMENT		ELECTRIC		ELECTRIC	
Dwelling		Brick		Electric		Inc		Flat Iron	
Flat		Stone		Gas		High Eff.		Percolator	
Office		Cement		Oil		Arcs		Radiator	
Store		Frame		Gasoline		Fans, Desk		Cook Outfit	
Factory		No. R'ms		Wired		Fans, Cel.		Chaf. Dish	
Saloon		Value		Piped		Window		Desk Lamp	
Misc.		Bath		Service		Sidewalk		W Heater	
Contract		Floor		Comb. Fix		Porch Light		Stove	

Sign { Owns ..... Rents ..... A. C. { Power D. C. { (over)

A Comprehensive Register for Solicitors.

Mr. Marshall feels that it more than pays to make very liberal rates, and intends to push harder than ever for business this year. At the present time this company is looking for an up-town office and intends to install an elaborate display room, etc. Mr. Marshall says that the best location that can be got will be none too good.

This company installed about twenty electric signs in the year 1906, with an average of over 100 lamps per sign. Previous to this date there was only one electric sign installed in Port Huron. To install these signs, the Port Huron Light and Power Company, with both advertising and solicitors, offered to hang all signs free and also offered to furnish a sign on twelve or twenty-four monthly payments, the company adding interest on its investment in these signs.

Another very clever and unique idea that was worked by this company was that of solicitors calling on the merchants and soliciting contracts for one year for a string of lights across the street, each string of lights being 100 feet apart; the merchants to pay *pro rata* according to merchants in the block. The cost to each merchant figured a trifle less than $1 per month. This scheme was adopted and used with great success, and after being used in certain parts of the city the merchants in other parts of the city were clamoring for a similar string of lights across the street in their block. This was certainly fine advertising for the merchants at a very low figure.

Another scheme which took very well in Port Huron was as follows: The company announced in the middle of the month, March, 1906, by newspaper and direct-by-mail advertising, that it would give all its prospective residence customers light free until May 1, providing they made contracts for electricity and had their houses wired at once. This idea was the cause of the company's putting electricity in a large number of residences which formerly used other forms of illumination.

Mr. Marshall also hit upon the scheme of placing square luminous signs in different places in the residence district, changing copy every week or ten days. These signs were turned on and off by patrolmen. One sign was placed by accident in front of the residence of the manager of the gas company, causing considerable amusement.

This company gives free renewals for "Gem" lamps and reflectors and is very successful in fighting the gas arc lamp with the "Gem" 250-watt lamp.

Flat-irons on thirty days' approval—

in fact, all modern methods—were used to introduce electric utensils.

The Port Huron people by direct-by-mail advertising, newspaper advertising and solicitors have demonstrated beyond a doubt that it pays to push with energy after new business, and it is the hope and ambition of Mr. Marshall to make a far better showing during the year 1907 than the excellent showing for the past year.

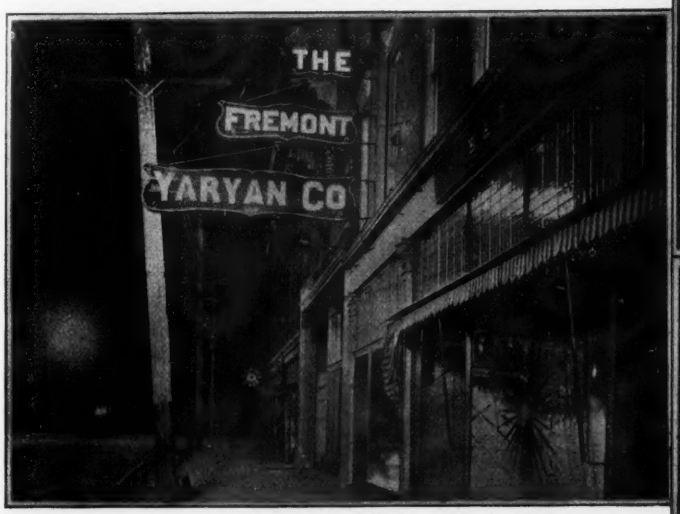
We have previously had occasion to briefly mention the Fremont Yaryan Company, of Fremont, Ohio, as being one of the companies located in a small city whose commercial enterprise commends it especially to the notice of central station men who are looking for new ideas and successful current-selling plans.

Considerable educational work is done in Fremont in the way of direct-by-mail advertising to present and possible consumers, but the interest stimulated in this way is not allowed to die for want of cultivation. Actual solicitation follows up the advertising, and, in addition, the public is constantly reminded of the company's presence, perhaps by reason of the fact that the company's office is situated in one of the best locations in the city and the company's message is heralded by a beautiful electric sign which extends out over the sidewalk and inspires confidence in Fremonters that electricity is a good trade-bringer, inasmuch as the electric lighting company takes its own medicine and uses a sign of this description as an aid to the securing of more business.

Moreover, the company's windows are always beautifully displayed. Portable lamps, electrical devices and appliances of all description are constantly shown in the windows and in the offices inside. This display is constantly changed and renewed so that the public is kept on the *qui vive* and is always looking for something new in the electric light company's windows.

The Tyler Electric Light and Power Company, of Tyler, Tex., is making most creditable efforts to insure 1907 being the most successful year in the history of this company so far as new-business growth and development is concerned.

The company is going out after the Tyler public with a strong, aggressive, direct-by-mail advertising campaign and, as a reinforcement to the mail advertising, seven-inch space is used daily in each of the two local newspapers.



The Fremont Yaryan Company's idea of advertising electricity and electrical devices.

A plan which has been adopted and found successful in gaining new customers is that of offering to give an electric flat-iron to any customer who brings the company another customer. This is something which other central station managers will do well to try out, because there can certainly be no question as to the advantage of having every customer on a company's books turn solicitor for the company.

Another evidence of the right spirit toward the public is the fact that free lamp renewals are given and unusual care is taken to see that lamps are renewed before they get below par.

There has been considerable discussion as to the merits and demerits of various forms of follow-up systems, and many suggestions for cards of varying degrees of excellence have been submitted and adopted by companies from time to time.

We are pleased to show herewith a form of card which has been found entirely satisfactory by the Commonwealth Power Company, which has adopted it, and we believe other central station managers will find that they can afford to look carefully into the merits of this card, perhaps with the result of adopting it for their own company. It seems unusually comprehensive.

R. D. Apperson, president of the Lynchburg Traction and Light Company, Lynchburg, Va., is very keen on methods of getting new business. This company quite recently inaugurated a series of "plain

traction talks" in the daily papers distributed in its territory. These talks have attracted a great deal of attention, and the vigorous manner in which the company has proceeded has redounded very much to its benefit. In addition to the advertising space occupied by the "plain traction talks," which occupy an average space of twelve inches, three columns wide, the company has from time to time some very interesting articles contributed by its representatives to the reading columns. These articles discuss such features as improvements in illuminants, utility of electrical devices and the futility of municipalization of public utilities. The Roanoke Railway and Electric Company, of which Mr. Apperson is also president, is conducting a similar campaign in the daily newspapers distributed in Roanoke, Va.

BOOK REVIEWS.

"Electric Ignition for Motor Vehicles." W. Hibbard. New York. The Macmillan Company. Boards. 128 pages. 4¼ by 6½ inches. Supplied by the ELECTRICAL REVIEW at 50 cents.

This book has been written in simple language, and is an attempt to deal with actual questions which arise in the handling of motor vehicles by men inexperienced with electrical phenomena. The contents include a general review of the subject, discussion on batteries, commutators and coils, magnetic fields, condensers, multi-cylinder engines and synchronous ignition, faults, and magneto methods of ignition. An appendix gives some data on the chemistry of a dry cell, the chemistry of an accumulator, the methods of charging storage batteries, and an explanation of electrical terms.

"The Engineering Index." Vol. IV. New York. *The Engineering Magazine.* Leather. 1,236 pages. 7 by 9½ inches. Supplied by the ELECTRICAL REVIEW at $7.50.

The present volume covers "The Engineering Index" for the five years 1901-1905. The work has been edited by Henry Harrison Suplee and J. H. Cuntz, in cooperation with Charles Buxton Going. This index is so well known and so much esteemed that it is difficult to add any word of praise to its established reputation. The references are given in alphabetical classifications and cross-references are frequent, making this a very valuable index for research work. One of the chief points of value of this work as a book of reference is the impartial presentation of the contents of all the known engineering publications. The list of periodicals indexed covers 250 technical and engineering journals in six different languages. In each case a brief abstract is given, showing the scope and purport of the article. It is the purpose of the publisher to issue the subsequent volumes of the index yearly.

Spreading the Gospel of Better Illumination.

Considerable interest is being taken in the work being done by Albert Jackson Marshall, of the engineering department of the Holophane Glass Company, New York city, in bringing the attention of the working forces of central stations and the customers of central station companies to the requirements and possibilities of illumination through the use of electricity. This work was started about a year ago as an experiment, but the results achieved have reached such a degree of importance, and the demand for the lectures has so increased, that Mr. Marshall is now devoting all his energies to going from one town to another and meeting with the representatives of the central stations and their customers.

In developing this lecture work a large amount of data has been brought together, supplemented by several hundred lantern slides, portable photometric cabinets and apparatus for graphic demonstrations. The subject is taken up in as simple and straightforward a manner as possible, so that those in the audience may easily comprehend the technicalities with which the subject is more or less burdened. One of the principal points which Mr. Marshall brings to the attention of his listeners is the fact that the conceptions of light and illumination must be kept absolutely separate and treated as individual considerations. Apparently the prime object of the central station man's business is to sell current, and, consequently, light; while the customer's demand is not so much for light as it is for illumination.

Instances are given during the course of the lectures of the vast improvements which may be brought about in the illumination of certain places by the proper placing of the light units and by properly assisting the light units with the use of auxiliary devices, such as shades and reflectors. Frequently there are many questions to answer, and in several instances the lecturer has been fortunate enough to make a practical demonstration of improving the illumination in stores and residences in the town in which the lecture is given. In some cases, where this improvement has been demonstrated, it has resulted in cutting down the current consumed by the customer whose illumination has been improved. Sometimes the central station manager has been shortsighted enough to complain bitterly of this condition, but in every instance the same party has been glad to acknowledge that the improved illumination in the one case has resulted in a demand for similar illumination in a dozen places where electricity was not used before. In this way alone the lecture work, as undertaken by Mr. Marshall, has been very gratifying. In other cases the inspiration and information given to the consulting force of the central station have been almost phenomenal in their results, and there is no possible chance for doubt as to the effect which these lectures have had in promoting, on the part of the consumer, a feeling of greater confidence in, and respect for, the supply corporation.

The company with which Mr. Marshall is connected is a pioneer in the agitation for the scientific working out of illuminating problems, and while the company is the manufacturer of several well-known auxiliary devices for controlling the illumination from electric lamps, its product is mentioned only incidentally during the course of the lectures. The company bears all the expense of Mr. Marshall's work, and is confident that in the general stimulation which follows such educational work as this, that it, along with the suppliers of electricity, will benefit greatly. As was stated before, so great has been the demand for the lectures that Mr. Marshall's itinerary is now laid out very much the same as an actor making one-night stands. It is the company's ambition, however, to place these lectures at the disposal of as many of the central stations as can guarantee a proper interest in them. The only concession which the company demands is that the central station organization in whose town the lecture is to be given shall provide a suitable hall, together with a stereopticon and an operator to handle it.

Illuminating Engineering Society.

A meeting of the New York section of the Illuminating Engineering Society was held at the Edison Auditorium on Friday, February 8. The following officers were elected for the ensuing year:

Chairman: A. E. Forstall.

Managers: M. K. Ayer, T. R. Beale.

Secretary: Preston S. Millar.

A paper entitled "Photometry of Incandescent Gas Lamps" was presented by Thomas J. Litle, Jr., of the Welsbach Company, Gloucester, N. J. This describes the photometer room equipment and the methods to be pursued in testing the mantle.

INDUSTRIAL SECTION

ILLUSTRATED DESCRIPTIONS OF NEW AND STANDARD ELECTRICAL AND MECHANICAL APPARATUS

Compania Electrica e Irrigadora, of Pachuca, Mexico.

The Compania Electrica e Irrigadora, of Pachuca, which for about six years has been supplying to the city of Pachuca electrical energy for power and lighting in that city from its Juando generating station, has now in process of construction a new plant, the Elba generating station, which has been found necessary to supply the rapidly increasing demand for power in Pachuca.

The new Elba generating station is located on the same stream, the waters of the drainage canal from Mexico City, as the Juando station. At the Juando station there is in operation apparatus approximating 3,000 horse-power, comprising six 375-kilowatt Westinghouse generators. The generators supply energy at 440 volts, raised to approximately 25,000 volts, three-phase, by means of banks of large transformers. At the Pachuca end of the transmission line this voltage is reduced to 2,200 volts for general distribution.

The company contracted with the Real del Monte mines for 5,000 horse-power, necessitating the construction of the Elba plant, which is to be modern in all its equipment. All of the new apparatus for the Elba plant, as well as the other necessary additions to the Juando plant and the receiving station at Pachuca, will come from the works of the Westinghouse Electric and Manufacturing Company, Pittsburg, Pa., which G. & O. Braniff & Company represent in the republic.

The Elba plant will be equipped with four 1,540-kilowatt generators, generating current at 2,200 volts. These generators will be driven by wheels made by Picard, Pictet & Company, of Geneva, Switzerland. There will be two 125-kilowatt exciter generators for exciting the fields of the alternators. The switchboard arrangement, together with the lightning protective apparatus and controlling switches, will be of the latest design. The main switchboard will comprise nine panels and the controlling switches will be of the oil-controlled type, operated from the main switchboard by electric contrivances.

The voltage of the generators is raised to approximately 25,000 volts by means of nine 540-kilowatt transformers, and the energy is transmitted as three-phase current to the Juando plant, where it is connected in multiple with the Juando circuits to Pachuca. A double pole line obviates the possibility of a shut-down which might occur on either of the circuits.

At the Juando station additional switchboard equipment is being provided for accomplishing the multiple connecting of the two generating stations, and in Pachuca a second receiving station has been built, in which will be installed an eleven-panel switchboard, with necessary distributing circuits.

Traveling cranes have also been provided in the new Elba station—a ten-ton crane over the transformers and a twenty-ton crane over the generators. The necessary transformers have been provided at this second Pachuca distributing station to handle the additional energy supplied by the Elba plant. Switching apparatus and ten 375-kilowatt Westinghouse transformers will be installed in the receiving substation for the Real del Monte Company at Loreto and Dificultad. The primary voltage will be 20,000 stepped down to approximately 6,000 volts.

The line to Pachuca is about fifty kilometres distant from Juando, and another line twenty-five kilometres in length was extended some time ago to Dublan, on the Central Railway, where a substation is located with complete equipment for supplying about 500 horse-power used in the cement works of the Compania de Cemento Portland, at that place. The latter company has found electricity to be so far superior to steam, not only in economy, but convenience as well, that arrangements are being made to double its present capacity.

Electrical Department of W. S. Barstow & Company.

C. T. Alden has been placed in charge of the recently organized electrical department of W. S. Barstow & Company, New York and Portland, Ore. Mr. Alden was formerly with the American Locomotive Company, Schenectady, as chief electrician and electrical engineer, then with the General Electric Company, and subsequently with the Bath Iron Works, Bath, Me., as engineer in charge of the electrical work of the U. S. S. "Georgia," and the scout cruiser "Chester." On the completion of this work in November, 1906, Mr. Alden assumed his present duties. M. O. Jenkins, assistant electrical engineer of this department, has had much experience at Schenectady and elsewhere in switchboard engineering and turbine work, as well as in general electric repairing and construction work. J. P. Read, who is also on the staff of this department, is an E. E. of Columbia University. Since his graduation from Rutgers College in 1901, Mr. Read has been in the employ of the New York & Long Island Railroad Company, Crocker-Wheeler Company, Helena Power Transmission Company, Butte, Mont., Westinghouse and other companies. The electrical construction foreman of this department is R. R. Pomeroy. In 1901 Mr. Pomeroy was stationed at Fort Wadsworth as assistant electrician until 1903, when he was sent to Fort McKinley, subsequently with the Brooklyn Edison Company, and with the Interborough Rapid Transit Company, and later with the New York Central & Hudson River Railroad in charge of various electrical work.

Annual Meeting of the Sales Staff of the H. W. Johns-Manville Company.

During the week beginning January 28 the various branch managers and department managers of the H. W. Johns-Manville Company held their annual convention at the headquarters of the company, 100 William street, New York city. This company has a world-wide reputation as a manufacturer of asbestos, magnesia and electrical products, having factories at Brooklyn, Milwaukee, West Milwaukee and Hartford, Ct., and branch offices and warerooms in the following cities: Milwaukee, Chicago, Boston, Philadelphia, St. Louis, Pittsburg, Cleveland, San Francisco, Los Angeles, Seattle, Kansas City, Minneapolis, New Orleans, Dallas and Buffalo. Representatives from the various branches and factories were present and the meeting was not only profitable but interesting to everyone present.

As a fitting finale, the convention wound up with a banquet at the Waldorf-Astoria, Friday evening, February 1.

"Universal" Insulator Supports.

The accompanying illustrations show several applications of the "Universal" insular supports (McFeaters patent) placed on the market by the Steel City Electric Company, Third street and Penn avenue, Pittsburg, Pa. One of the principal applications of these supports is to simplify the wiring in steel-frame mill and factory work. The supports can be used in any position on the flanges of any known rolled-steel structural shapes — beams, angles, channel, Z bars, round, square and flat bars; gas and water pipes, edges of tanks or plates. No woodwork is required and no drilling of holes is necessary. The use of cup-pointed, hardened set screws and a clamp of great strength prevents the supports from working loose, even under severe vibration.

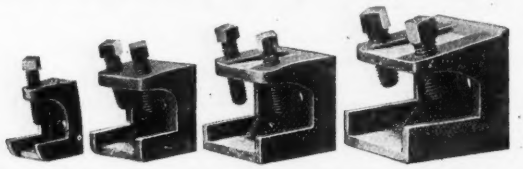


FIG. 1.—FOUR SIZES OF "UNIVERSAL" INSULATOR SUPPORTERS.

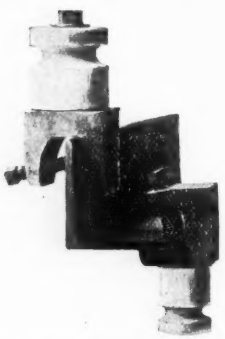


FIG. 2.—SUPPORTERS ATTACHED TO ANGLE IRON.

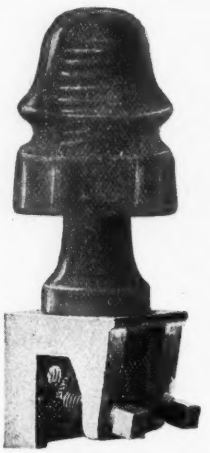


FIG. 3.—SUPPORTER WITH GLASS INSULATOR AND PIN.

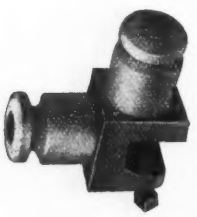


FIG. 4.—SUPPORTER WITH TWO INSULATORS.

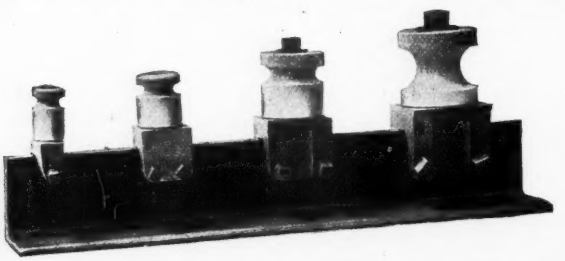


FIG. 5.—FOUR SIZES OF SUPPORTERS ATTACHED TO ANGLE IRON.

Fig. 1 shows four sizes of these supports, taking all sizes of porcelain and glass insulators. The illustration has been reduced from one inch, one and one-half, two and two and one-half inch sizes, respectively. Fig. 2 shows a two-inch and a one and one-half inch support with insulators applied to angle iron. Fig. 3 shows a two and one-half inch size with a glass insulator and pin. Fig. 4 shows a one and one-half inch support with two No. 4 insulators. Fig. 5 shows the application of one size of each support with one insulator each attached to angle iron. Fig. 6 shows the two and one-half inch support with a porcelain spool insulator.

FIG. 6.—SUPPORTER WITH PORCELAIN SPOOL INSULATOR.

These insulators are made of malleable iron and will withstand rough use without breaking.

Westinghouse Small Power Motors Operating Beer Pumps.

In the industrial and commercial field there are numerous operations requiring small amounts of power which have usually been laboriously performed by hand, owing to the lack of some convenient and inexpensive driving mechanism. With the growth of the electrical industry and its extension into new lines of work more attention has been given to the development and perfection of small power motors. In hotels, saloons and breweries there are many applications, such as bottle cleaners, automatic air compressors, beer pumps, etc. In Fig. 1 a Westinghouse one-eighth-horse-power small power motor for alternating current circuits is shown driving a type "A" single-cylinder beer pump, for hotel and saloon use, manufactured by the E. R. Brown Beer Pump Company of Boston, Mass. A Brown type

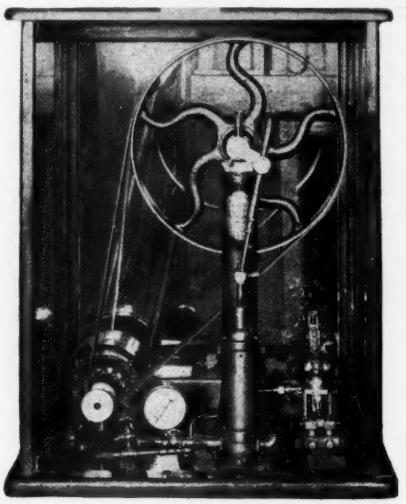


FIG. 1.—ALTERNATING-CURRENT ONE-EIGHTH-HORSE-POWER MOTOR DRIVING BEER PUMP.

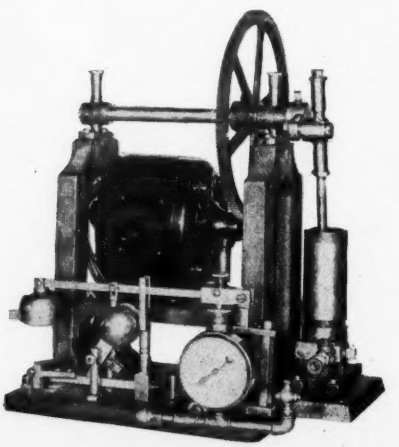


FIG. 2.—ALTERNATING-CURRENT ONE-EIGHTH HORSE-POWER MOTOR DRIVING BEER PUMP.

"B" single-cylinder beer pump driven by a similar motor is illustrated in Fig. 2.

These motors are compact, neat in appearance and thoroughly reliable in operation. They are built for both alternating and direct-current circuits, either 115 or 230 volts. The direct-current motors are either shunt or series wound and the alternating current motors are wound for twenty-five, sixty or 133 cycles. The base of the motor consists of separate casting, the frame being drilled and tapped so that the feet may be fastened in any one of four positions, adapting them to use on floor, wall or ceiling.

The Blake Tube Flux.

The accompanying illustration shows a practical application in motor repair and construction of the new form of tube flux placed on the market by the Blake Signal and Manufacturing Company, 246 Summer street, Boston, Mass. This flux is put up in a new form of collapsible tube which has been made stronger and heavier than usual, and is tinned both inside and out. The flux is stated to be a thoroughly insulating non-corrosive soldering flux. The spout in the tube is aluminum, and allows the paste to be applied directly to the joint at the same time with the heat, without soldering up the vent.

Adaptation of Tube Soldering Flux.

Escalators Which Will Break the Record for Size.

The New York & Long Island Railway Company, known as the Belmont or old Steinway tunnel system, has just awarded a contract, says the *American Machinist*, to the Otis Elevator Company for the two largest escalators ever built, to be installed in the Manhattan terminal of that system at Forty-second street, between Lexington and Third avenues. Trolley cars instead of trains are to be operated in this tunnel, and they will run on short headway, providing a tremendous capacity, which, it is estimated, will be at least equal to that of the trains of the present Brooklyn Bridge during rush hours; the escalator equipment above referred to will be equal in point of capacity to that of the entire stairway equipment of the Manhattan end of the Brooklyn Bridge. Furthermore, not only will the escalators be sufficient to handle any number of people up to the capacity of the trolley cars of the tunnel, but they will also serve to marshal the crowds into streams of people moving uninterruptedly and not coming into conflict with one another. The escalators will provide service between levels something over fifty-five feet apart, and will be arranged side by side. Most of the time one will be operated ascending and the other descending, but during the morning rush hour both will be operated ascending.

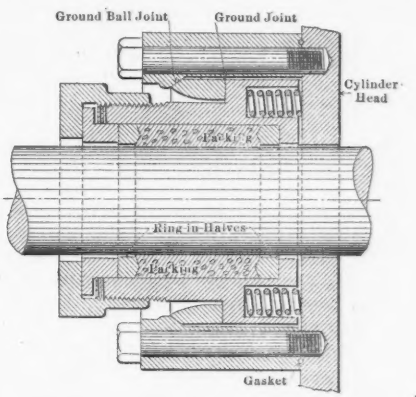
As an appropriation has already been made for a new Manhattan terminal to the Brooklyn Bridge, to be located underground, it will be interesting to note whether this municipally owned enterprise will be as progressive as the privately owned one in the matter of installing moving stairways.

The escalators, in common with the entire terminal, possess no woodwork or other inflammable material. As is well known, the escalator is the invention of Charles D. Seeberger, who is now head of that department of the Otis Elevator Company.

In connection with these tunnels, it may be interesting to mention that the chief engineer of the board of estimate is reported to have found that the shields in the north tube under the East river still lack 600 feet of meeting, and the south tube shields are 750 feet apart. This failure to finish the work by January 1, as provided in the old Steinway grant, has resulted in the raising of a legal question as to the status of the franchise rights.

A Vibrating Stuffing Box.

The accompanying illustration shows the vibrating stuffing box which has been designed by the Steel Mill Packing Company, Detroit, Mich. This stuffing box is constructed to automatically adjust itself to any out-of-line movement of the piston rod and stem. The stuffing box is arranged within a casing, and is held firmly against the ground ball joint ring by means of springs, assisted by the steam pressure from the cylinder, keeping the joints tight and preventing leakage. A clearance is provided between the stuffing box and the interior of the casing, and between the rear surface of the stuffing box and the cylinder head. This permits the stuffing box to move laterally relative to the casing to compensate for out-of-line movement of the rod and stem, and to rock on the curved face or ball joint to adapt itself to any angular movement of the rod. The spacing rings at each end of the packing work in connection with the packing, holding the stuffing box out of contact with the moving parts, thus preventing wear.



Arrangement of Parts, Vibrating Stuffing Box.

The company states that one of these stuffing boxes, placed on the main piston rod of a 100-horse-power engine in the Butterfield Power Building, Detroit, Mich., so as to have an angular as well as a lateral movement of one-sixteenth of an inch, has been found to work perfectly. The box may be packed with any suitable packing.

Current Electrical News

DOMESTIC AND EXPORT.

TRACTION LINES MERGED—The consolidation of the traction interests operating between Erie and Buffalo, N. Y., which has been in progress for a year or more, has been practically completed by the Buffalo & Lake Erie Traction Company of the Hamburg Railway, and the Erie Rapid Transit Company. In all there are five traction enterprises merged in the Buffalo & Lake Erie Company, and the latter has plans under way for the building of the links necessary to make the chain between Buffalo and Erie complete. The holding company is capitalized at $6,750,000, of which $2,500,000 is preferred. A general mortgage bond issue has been authorized, the greater part of which will be utilized to take up present obligations and push the improvements and extensions under way.

NEW SOUTH CAROLINA PUBLIC SERVICE COMPANY—The charter of the South Carolina Public Service Corporation has been filed for record. The company, as stated in the charter, proposes to build and operate an electric line from Charleston, S. C., by way of Orangeburg to Columbia and thence to Augusta, with the privilege of extending its lines to Charlotte, N. C. The minimum capital stock of the corporation is set down at $500,000 and the maximum stock at $10,000,000. Following are the names of the incorporators: Joseph J. Timmes, J. C. La Vin, Joseph A. Bill, George Fleck, Jr.; John P. Bonney, Charles R. Van Etten and John F. Timmes, of Brooklyn, N. Y.; John C. Lott, of New York, N. Y.; John A. Craig, Sol Kohn and Robert H. Jennings, of Orangeburg. The headquarters of the corporation will be in Columbia.

CONDOR WATER AND POWER COMPANY TO INCREASE CAPACITY—Because of the increasing demand made upon it for mining power, brought about by the development and operation of the surrounding mines, the Condor Water and Power Company, Tolo, Ore., has been obliged to double its capacity. The central plant of the company is at Gold Bay, on Rogue river, whence it distributes electric energy to all the districts of Josephine and Jackson counties. The company is now placing at its various distributing points, transforming plants by which the carrying capacity of the aluminum lines will be increased from 20,000 to 40,000 volts. Power lines have been strung to every important mine or mining district within a radius of fifty miles of Gold Bay. The dam across Rogue river, which develops the power for the enterprise, raises the water to a height of twenty feet, and develops over 15,000 horse-power.

TO SETTLE CHICAGO TRACTION QUESTION—The Chicago, Ill., city council, by a vote of fifty-six to thirteen, has adopted an ordinance which, if approved by the voters at the April election, will settle Chicago's traction question, which has been before the people for more than ten years. The ordinance adopted provides that the city shall issue twenty-year franchises to the Chicago City Railway Company, and the Union Traction Company, with the understanding that on six months' notice at any time the city may purchase the street railways controlled by the companies for $50,000,000, plus the cost of rehabilitation. The companies are at once to reconstruct and reequip all the lines, under the supervision of three experts, one to be appointed by the city and the other two by the street railway companies. Under the new ordinance the street railway companies, for the usual fare of five cents, will grant universal transfers to all parts of the city. The city will receive fifty-five per cent of the net income of the street railways in question.

TELEPHONE COMPANY SOLD—A circular has been issued to stock and bondholders of the United States Independent Telephone Company, of Rochester, N. Y., announcing that an agreement has been reached between the holders of $6,000,000 of the company's bonds and a trust company, which is not named, to take over the entire bond issue of $13,316,000 of the company at thirty-five, $4,782,200 of its stock at five, and the deferred stock, used to purchase the New York Independent Telephone Company's franchise, at one. It is believed that the trust company referred to is acting for the American Telephone and Telegraph Company. The circular is signed by the following directors of the Independent company: George Eastman, H. W. Sibley, James S. Watson, Walter B. Duffy, Thomas W. Finucane and Edward Bausch. According to interests identified with the Independent company, the deal is made conditional upon the underwriting by the United States Independent Telephone Company stock and bondholders of $4,000,000 of the four per cent convertible bonds of the American Telephone and Telegraph Company.

SUSQUEHANNA POWER CASES DECIDED—In the cases of the Susquehanna Power Company against the proprietors of the Susquehanna Canal and the Conowingo Land Company, a decision has been rendered by Judge Crothers, of the Circuit Court for Cecil county, Md., confirming the inquisitions in both cases. The properties have been condemned by the Susquehanna Power Company for the purpose of developing electric power on the Susquehanna river by the construction of a dam from the Hartford (Pa.) and Cecil (Md.) shores. The case will now go to the Court of Appeals. The present litigation is an effort on the part of the Susquehanna Canal Company (which is virtually the McCall Ferry Company) to have the court in Cecil set aside the proceedings of the jury condemnations, which last summer awarded the Susquehanna Canal Company $55,627 and the Conowingo Land Company $52,964. The case of the Deland Milling and Mining Company was settled out of court, the Susquehanna Power Company agreeing to restore to the Deland company the buildings and machinery previously condemned, to allow said buildings and machinery to remain on the condemned land for five years and to pay to the Deland company $8,100, or $1,000 more than was awarded it by the jury of condemnation.

ANNUAL REPORT OF THE MEXICAN LIGHT AND POWER COMPANY—The Mexican Light, Heat and Power Company, in its annual statement for the fiscal year ending December 31, shows gross earnings of $3,854,194; operating expenses, $1,476,609; net earnings, Mexican currency, $2,377,219; net earnings, gold, $1,188,609. The company, out of its net earnings of $1,188,609, gold, applied $133,323 gold for the maintenance of its plants, and carried the balance of $1,075,283 gold, to profit and loss account. The operating expenses of $1,476,975, Mexican currency, include $581,504, which was the cost of steam power during the year, pending the completion of the hydraulic plant. The net earnings fell $97,391 gold below the estimates for the year. The directors in their report state that the deficiency is due to three causes: 1. The Tramway Company was unable to secure from the manufacturers and to install its machinery so as to be able to take power on October 1 last as agreed. 2. The mining companies at El Oro encountered similar delays in procuring machinery from the manufacturers and they also operated with less power than was expected. 3. The city of Mexico did not make certain anticipated extensions in the public lighting. The general balance sheet shows assets of $28,661,360.05, of which the chief items are properties, franchises, concessions, $24,350,456.46, and Mexican Electric Light Company, $3,000,000. The liabilities are $27,610,332.52, of which $13,000,000 are bonds, and $13,585,000 issued stock.

ELECTRIC RAILWAYS.

EAU CLAIRE, WIS.—The common council of Menominie has passed the various franchises which the Chippewa Valley Electric Railway Company has been asking for for some time.

CENTRALIA, ILL.—The Centralia Traction Company has perfected arrangements to extend its line to Junction City and Sandoval. Work will be started as soon as the weather will permit.

SALT LAKE CITY, UTAH—The city council has granted the Ogden Rapid Transit Company a new fifty-year franchise. Before

passing the measure a number of amendments were made, the most important of which was a $50,000 occupation tax.

WAYNESBORO, PA.—At the annual meeting of the Chambersburg, Greencastle & Waynesboro Street Railway Company, George B. Beaver, of Waynesboro, was reelected president; R. W. Ramsey, vice-president; D. M. Wertz, treasurer; H. B. McNulty, secretary; John M. Wolff, general manager.

CORRY, PA.—The annual meeting of the directors of the Erie, Union City, Cambridge & Corry Trolley Company was held on January 21. The recent death of Perry Gibson necessitated a reorganization of the company, and the following officers were chosen: president, Charles Manbibber, Boston; secretary, John Doll, Erie; treasurer, Hon. F. L. Beskins, Conneaut, Ohio.

MADISON, WIS.—Articles incorporating the Wisconsin Electric Railway Company, of Milwaukee, have been filed in the office of the secretary of state. The incorporators are W. D. Hickman, W. F. Adams, and A. R. Denu. The capital stock of the new company is $50,000, which is divided into 500 shares of $100 each. The company has the right to increase its capital stock at any time.

BURLEY, IDAHO—The commissioners of Cassia county, Ida., have granted a charter to W. D. Kenyon, Paul R. Kartzke, J. C. Rogers, I. G. Hale and T. B. Lee, to build a line of railway from the south bank of the Snake river at Burley to Oakley, twenty-five miles. The cost of building and equipping the road is estimated at $100,000 and the scheme is to be financed by Idaho capital.

SPOKANE, WASH.—C. A. Barron, general superintendent, announces that the Puget Sound-Chelan-Spokane Company, incorporated for $12,000,000; the Snohomish Valley Railway Company, $2,500,000, and the Puyallup Valley Northern Rapid Transit Company, $3,000,000, will build an electric road from Spokane to the Sound, 450 miles, to be completed in 1909. Contracts for part of the work have been awarded. Mr. Barron says the bonds for the Snohomish line have been sold.

COLUMBUS. OHIO—The Fremont Belt Connecting Railway Company, of Toledo, $1,000, has been incorporated by Webb C. Hayes, John W. Horst, John M. Sherman, Frank Heim, Charles Thompson and A. H. Jackson. They propose a traction line running from a point in the line of the Toledo, Port Clinton & Lakeside railway's track, through Salem, Rice and Sandusky townships, and into Baleulb township, Ottawa county. The purpose is to give the traction line access to the new state camp grounds and rifle range of the state near Port Clinton.

JEFFERSON CITY, MO.—Lee A. Hall has filed, in the office of the secretary of state, the articles of incorporation of the Central Suburban Traction Company, of St. Louis, capitalized at $50,000. All the stock, save ten shares, is held by St. Louisans. Charles A. Gutke holds 460 shares of the stock and Hall ten. Both these gentlemen are interested in the St. Louis, Montesano & Southern Railway, which was incorporated in September last, and which proposes to build an electric line from the southern limits of St. Louis to Flat River, a town in St. Francois county.

SPRINGFIELD, MO.—C. C. McFann, of Nevada, Mo., general manager of the Kansas City, Springfield & Southern Railway, the electric line that has been projected from Nevada to Springfield, has arranged to begin the preliminary work. Mr. McFann says that all the right of way, with the exception of nine miles, has been secured, and that construction work on the road will be commenced within the next sixty days. Every town along the route has pledged from $2,000 to $30,000 to aid in the building, in addition to giving right of way and the use of streets. The length of the road, including one branch line from Stockton to Sylvania, is 195 miles.

NORFOLK, VA.—The railway lines and other property of the Bayshore Terminal Company, it is announced, will shortly pass into the hands of the Norfolk & Portsmouth Traction Company, of which R. Lancaster Williams, of Baltimore, is president, now controlling all but one of the other lines in this vicinity. The property has been in the hands of receivers for about three years. Last spring it was sold under a court order to E. B. Smith & Company, of Philadelphia, for $765,000, the purchasers acting in the interests of the traction company. A holding corporation, the securities of which will be held by the traction company, will be organized to take over the property.

SPOKANE, WASH.—Col. W. H. Plummer, president of the Spokane and Big Bend Railway, announces that a traffic arrangement has been made with Jay P. Graves, president of the Spokane & Inland Empire system, to run its cars in and out of Spokane over the latter's line to be built to Seven Mile Bridge, also that a line will be constructed to Davenport, thirty-seven miles. Grading is to be begun at once. A syndicate at St. Louis, Mo., it is announced, will finance the project, taking $2,500,000 in five per cent, ten-year bonds, certified by the Spokane & Eastern Trust Company. The line will tap the Big Bend country, the richest wheat belt in eastern Washington.

CLEVELAND, OHIO—The Cleveland & Southwestern Railway Company has voted to change its name to the Cleveland, Southwestern & Columbus Railway Company and to extend the line to Columbus. The company was formed last summer from the consolidation of the Cleveland & Southwestern, the Cleveland, Ashland & Mansfield and the Ohio Central. At the consolidation the stock and bonds were increased so that the company now has $5,000,000 in the treasury, which would be sufficient to build the extension. Either an entirely new line will be built or a connection made from the Ohio Central to the Columbus, Delaware & Marion.

TOPEKA, KAN.—The Stranger Valley Electric Railway Company, composed of men in and around Tonganoxie, has purchased the right of way for an electric railroad to be built from Kansas City to Topeka, *via* Tonganoxie and Lawrence, with a branch running north from Tonganoxie to Atchison. The chief promoter of the projected road is W. Laming, of Tonganoxie. The projected road from Kansas City to Tonganoxie runs a few miles south of the Missouri Pacific. From Tonganoxie the main line goes to North Lawrence and thence on to Topeka on the north side of the Kansas river. The Atchison branch leaves the main line at Tonganoxie and runs due north to Atchison *via* Easton.

PHILADELPHIA, PA.—The Interstate Railway Company has purchased the Philadelphia, Bristol & Trenton Street Railway and will operate it in connection with its lines from Torresdale. The trip from Torresdale to Trenton will be a continuous one. The Philadelphia, Bristol & Trenton operates over twenty-three miles of track, but at present its cars enter Trenton over the right of way of the Johnson line. The Philadelphia line has its own tracks as far as the Morrisville bridge over the Delaware, and as this is credited with being controlled by the Pennsylvania Railroad Company, which is said to be on friendly terms with the Interstate Company, it is likely that it will soon enter the city on its own tracks over this bridge.

PADUCAH, KY.—Direct connection between St. Louis and Paducah by a standard-gauge railroad, operating steam and electric cars, is assured by the filing of articles of incorporation of the Paducah Southern Railroad Company. The line described is between Paducah and Hickman, Ky., but the same people have secured rights of way through Brookport, Metropolis, Golconda, Joppa and southern and western Illinois towns to East St. Louis, and in a year promise to have the St. Louis line in operation. The capital is $50,000, but $2,000,000 of bonds, it is said, have been floated in New York. The company will handle both freight and passengers. D. A. Archer is the promoter, and local people interested are B. H. Scott, H. H. Loving, Ben Weille and W. A. Martin.

AKRON, OHIO—Moderate gains in gross and net earnings and in its surplus are shown in the annual report of the Northern Ohio Traction and Light Company for the fiscal year ended December 31, 1906. Gross earnings of the combined properties during last year aggregated $1,703,340, an increase of $150,370 over those during 1905, while net earnings involved $696,498, an increase of $42,358 over those for the previous year. The surplus for the year aggregated $213,325, an increase of $30,688 over that for 1905. This gain in the surplus account was made despite the fact that charges increased $11,670. The total gross revenue from the railway alone during last year amounted to $1,577,090, compared with $1,431,057 for 1905, an increase of $146,033 or 10.2 per cent. The average earnings per mile of track on all divisions were $7,885, compared with $7,209 in 1905. The total gross revenue from lighting during 1906 was $126,249, compared with $121,912 in 1905, an increase of $4,339 or 3.55 per cent.

ELECTRIC LIGHTING.

ASHLAND, WIS.—At a special election it was voted to install a municipal electric lighting plant.

CANAAN, CT.—The village of Millerton has entered into a five-year street-lighting contract with the Berkshire Power Company.

SINCLAIRVILLE, N. Y.—A contract for street lighting at Sinclairville has been awarded to the Jamestown Electric Company.

CHICAGO, ILL.—The Commonwealth Electric Company has taken over the wires and poles of the North Shore Electric Company. Most of the business of the North Shore company is outside the city limits.

TYRONE, PA.—The Alforata Electric Light Company has organized with John Philips, president; Henry Knade, vice-president; Samuel I. Spyker, secretary; W. S. Kenega, treasurer. The capital of the company is $75,000.

FORT SMITH, TEX.—The city council has adopted a resolution to enter into a contract with the Fort Smith Light and Traction Company for a minimum number of 2,000-candle-power street lights, at $55 per light, under a ten-year franchise.

EDWARDSVILLE, ILL.—The Madison County Light and Power Company has filed a $1,000,000 mortgage on its property in Madison county to the Central Trust Company of Illinois, covering its lands and chattels in Edwardsville, Granite City, Madison and Venice.

MORLEY, MICH.—The Grand Rapids-Muskegon Power Company is planning a third dam on the Big Muskegon river, near Whitney's bridge, ten miles west of Morley. It will be a year before the company's second dam will be completed at Croton, where 275 men are employed.

NEWBURGH, N. Y.—The stockholders of the Newburgh Light, Heat and Power Company at their annual meeting elected the following directors: W. R. Beal, T. R. Beal, R. A. Davidson and F. N. Bain. The directors met and elected W. R. Beal president and T. R. Beal secretary and treasurer.

LONG BRANCH, N. J.—At a meeting of the mayor and council of the borough of Seabright the lighting contract with the Seabright Electric Light Company was renewed for the present year. The council pays $95 for arc lights and $15 for incandescent lights per year. There are twenty-one arc lights and twenty-two incandescent lights in use.

PORTLAND, ORE.—The application of the Portland General Electric Company for a permit to construct conduits and lay wires under ground has been presented to the executive committee together with a $10,000 bond. The bond guarantees that the company will comply with the provisions of the ordinance and will protect the city against any loss.

NEWCASTLE, IND.—A deal has been closed whereby an eastern syndicate secures control of the light, heat and power company plant and business here. The price paid was fifteen cents on the dollar, and the syndicate assumes bonds amounting to $50,000 and other liabilities. The new owners intend to increase the size of the plant and install an artificial gas plant for light and fuel.

GREAT BARRINGTON, MASS.—The Great Barrington Electric Light Company at its annual meeting elected the following directors: Frank Curtiss, Parley A. Russell and F. H. Wright. The following officers were chosen: president, Frank Curtiss; vice-president, Parley A. Russell; treasurer and general manager, Parley A Russell; clerk, Frank H. Wright; superintendent, Clyde Parrish.

GREENFIELD, MASS.—The Greenfield Electric Light and Power Company at its annual meeting elected these directors: F. O. Wells, W. M. Pratt, C. C. Dyer, William B. Allen, J. W. Stevens, and Philip Cabot and Winthrop Coffin, both of Boston, representing the new owners of one-fourth the company's stock. J. W. Stevens is president, George W. Lawrence treasurer, and Charles H. Keith clerk.

ELGIN, ILL.—Bonds have been voted by the village board of Maple Park to defray the cost of the installation of an electric light system within the borders of the corporation. The cost, it is estimated, will be in the neighborhood of $5,000. Worst & Shepardson, of Aurora, are preparing the plans for the work, which is to be completed by May 1 of this year. The plans call for twelve arc lights and thirty-two incandescent lamps.

CLARINDA, IOWA—At the annual meeting of the stockholders of the Lee Electric Light Company, W. T. S. White was elected a director in place of L. W. Lewis, who has removed to Seattle, Wash. There was no change in the other directors, who were reelected, as follows: J. R. Lee, Rufus E. Lee, G. William Richardson, and William Orr. The directors chose J. R. Lee for president, G. William Richardson, vice-president, and Rufus E. Lee, secretary, treasurer and manager.

PAWTUCKET, R. I.—A bill has been introduced in the Legislature authorizing the Pawtucket Electric Company to issue $2,000,000 of bonds on its properties, to refund the present bonded debt, take up the floating debt and provide for extension. H. W. Fitz, treasurer of the company, stated that it was not the intention of the company to sell the entire amount at once. He said only about $250,000 would be issued after the bill passed, and the remainder would be floated as occasion demanded.

INDIANAPOLIS, IND.—The city controller has received a statement from the Indianapolis Light and Heat Company, which gives an account of the company's gross receipts during the year of 1906. The receipts for the year amounted to $474,641.51. Of this amount the city receives five per cent, $23,732.08, for special franchise tax. The Indianapolis Light and Heat Company furnishes the lights for all of the city's public buildings with the exception of the city offices, which are located in the basement of the court house.

SPOKANE, WASH.—Harry M. Richards, president of the Washington Water Power Company, announces that plans are being made for increasing the company's output 10,000 horse-power, using the waters of the upper and lower falls in Spokane, 50,000 horse-power; Post Falls, in the Spokane river in Idaho, 15,000 horse-power, and the building of a steam auxiliary plant to develop 6,000 horse-power. The company purposes increasing its capital from $5,000,000 to $10,000,000 at a meeting of stockholders called for March 4.

BALTIMORE, MD.—The Consolidated Gas, Electric Light and Power Company of Baltimore has acquired from the Roland Park Company all the capital stock of the Roland Park Electric and Water Company. The latter corporation is a subsidiary company of the Roland Park Company, operating the electric light and water plants in Roland Park. The entire water plant of the electric and water company under the agreement of sale which has been made is retained by the Roland Park Company, which will continue to own and operate this department.

DENISON, TEX—At a meeting of the stockholders and directors of the Denison Light and Power Company it was decided to make extensive improvements to both the gas and electric light plants which will cost approximately $50,000. The old board of directors was reelected and consists of W. B. and J. T. Munson, J. B. McDougall, all of Denison, and John Scullin and C. Gilbert, the latter two from St. Louis. The officers of the company for the ensuing year are: W. B. Munson, president; J. B. McDougall, vice-president; W. A. Everitt, secretary and manager.

NORWICH, CT.—The Uncas Power Company, which has been organized at Norwich, Ct., has elected Charles W. Comstock president, John D. Hall secretary, and Costello Lippitt treasurer. The company has a capitalization of $50,000, six per cent cumulative preferred stock, while common shares amounting to about $100,000 will be issued. The company will issue five per cent bonds in the sum of $150,000. The management expects to expend approximately $200,000 in the construction of a power-plant. The company has acquired a valuable water privilege on the Shetucket river three miles north of Baltic.

WATERTOWN, N. Y.—The state commission on gas and electricity has denied the application of the lighting interests of Watertown to consolidate. A new corporation was formed and application made to merge the Watertown Gas Light Company and the Watertown Electric Light Company and to obtain additional water power. It was proposed to capitalize these properties at $1,800,000. The commission examined the plants of the companies and the local conditions existing at Watertown, and decided that it would be

against the interests of the consumers of gas and electricity to allow a consolidation. The commission also decided that the capitalization asked for was excessive and would overload the company, and instead of allowing a capitalization of $1,800,000 asked for, only $700,000 of stock and bonds were conditionally consented to by the commission.

HUNTINGTON PARK, CAL.—At a meeting of the citizens of Huntington Park it was decided to call an election to vote on the question of installing a municipal light plant. It is proposed to issue bonds not to exceed $20,000 for this purpose.

PROVIDENCE, R. I.—A bill to incorporate the Scituate Light and Power Company, with a capitalization of $250,000, to do a general electric lighting and power business in towns in the western and northern part of the state, has been introduced in the house by Representative Albert N. Luther, of Scituate. The incorporators named in the bill are William E. Joslin, of Scituate, and Edwin A. Smith and William H. Joslin, of this city. The new company intends so soon as its incorporation is approved by the general assembly to furnish power and lighting in the towns of Scituate, Burrillville, Gloucester and Foster, a section of the state which is not now being exploited by any electrical company save the Narragansett Electric Lighting Company, which furnishes power to a mill in the village of Hope in the town of Scituate.

HARRISBURG, PA.—Letters-patent and a charter granted on January 10, 1907, to the Harwood Electric Power Company have been filed. The charter and letters-patent are to be perpetual and the company is given the right to locate an extensive electric plant in Hazle township for the purpose of furnishing electric light, power and heat. The general office of the company is in Philadelphia and the directors are the following: Calvin Pardee, Alfred D. Pardee and Ario Pardee, all of Whitemarsh, Pa.; Calvin Pardee, Jr., and A. W. Drake, of Hazleton. Ario Pardee is the treasurer of the concern. The capital stock of the company is $50,000, consisting of 500 shares valued at $100 each and $5,000 of the capital stock has been paid into the treasury. This is the concern that asked the state to grant it the privilege of manufacturing heat, power and light and furnishing the same to patrons in Luzerne, Columbia, Schuylkill, Carbon and adjoining counties, and even to Philadelphia. The state department refused to give the company such extensive rights, and the charter granted gives it permission to furnish its products to residents of Hazle township and vicinity. The fuel for this extensive plant is to be taken from the culm, rock, gob and dirt banks at the workings of the Pardee coal properties which up to this time it has been impossible to utilize for fuel or other purposes.

DATES AHEAD.

Underwriters' National Electric Association. Annual meeting Electrical Committee, New York city, March 27-28.

Ohio Independent Telephone Association. Annual convention, Columbus, Ohio, March 28.

Iowa Electrical Association and Iowa Street and Interurban Railway Association, Clinton, Iowa, April 18, 19 and 20.

Jamestown Tercentennial Exposition. Norfolk, Va., April 26 to November 30.

Railway Telegraph Superintendents' Association. Annual meeting, Atlantic City, N. J., June 19-20.

PERSONAL MENTION.

MR. L. S. KIRKER, who has been manager for the City & Elm Grove Railway Company, of Wheeling, W. Va., for a number of years, has resigned and is succeeded by Mr. J. W. Smith, of Philadelphia.

MR. T. E. ARGO has been appointed traffic superintendent of the Western Union Telegraph Company, at Atlanta, Ga. Mr. Argo entered the employ of the company as an operator, and has been steadily advanced.

MR. CONVERSE D. MARSH, of the Bates Advertising Company, New York city, has been retained as advertising advisory counsel for Messrs. Stone & Webster, of Boston, the well-known owners and builders of electrical properties.

MR. JOHN FLOOD, who has served for sixteen years as superintendent and assistant superintendent of the Steubenville (Ohio) Traction Company, has resigned to accept the superintendency of the Tri-State Traction Company which operates a line from Steubenville to Wellsburg, W. Va.

MR. F. D. LAWRENCE, president of the F. D. Lawrence Electric Company, Cincinnati, Ohio, was a visitor to New York during the past week. Mr. Lawrence reports a good business for electrical supplies and was busy looking after the interests of the progressive house of which he is the head.

MR. H. C. SLEMIN has been appointed advertising manager of the Stromberg-Carlson Telephone Manufacturing Company, *vice* Mr. J. O. Oliver, who becomes more closely connected with the sales organization of the company. Mr. Slemin was formerly connected with the engineering and sales departments.

MR. J. S. FRANCIS has been appointed engineer of the Bell Telephone Company, of Philadelphia, Pa. Other recent appointments are: Mr. W. R. Stein, chief clerk, Philadelphia division manager's office, effective February 1; Mr. H. Wood, from assistant cashier, Tioga district contract office, to chief clerk, effective January 19; Mr. J. H. Carrol, chief clerk, New Jersey division, plant department, effective January 14.

ELECTRICAL SECURITIES.

Last week the market conditions were greatly improved, with a much firmer undertone and considerably less short selling. Money conditions were easier and it is felt that with the several adverse factors which have been threatening the market's stability for some time being happily eliminated the chances for a low money rate were very good. The present indications from industrial centres would seem to show that there has been no let-up in the general prosperity. What apprehension might be felt at the somewhat disappointing winter wheat showing has been relieved by the distinct change in weather conditions which has been experienced in the last two weeks. Any tendency toward slackening in business, also, due to the extreme cold weather, it is assumed, has been discounted by the market in its recent decline, so that the present expectation is that the market will soon experience another speculative period, with advancing prices this time.

ELECTRICAL SECURITIES FOR WEEK ENDING FEBRUARY 9.

New York:	*Closing.*
Allis-Chalmers common	14¾
Allis-Chalmers preferred	38
Brooklyn Rapid Transit	73
Consolidated Gas	134
General Electric	160
Interborough-Metropolitan common	34½
Interborough-Metropolitan preferred	71
Kings County Electric	140
Mackay Companies (Postal Telegraph and Cables) common	72
Mackay Companies (Postal Telegraph and Cables) preferred	69½
Manhattan Elevated	142½
Metropolitan Street Railway	104
New York & New Jersey Telephone	112
Western Union	82½
Westinghouse Manufacturing Company	150

Boston:	*Closing.*
American Telephone and Telegraph	128¼
Edison Electric Illuminating	225
Massachusetts Electric	68½
New England Telephone	123
Western Telephone and Telegraph preferred	77

Philadelphia:	*Closing.*
Electric Company of America	10¼
Electric Storage Battery common	64
Electric Storage Battery preferred	64
Philadelphia Electric	8
Philadelphia Rapid Transit	21
United Gas Improvement	94

Chicago:	*Closing.*
Chicago Telephone	116
Chicago Edison Light	141
Metropolitan Elevated preferred	70
National Carbon common	81
National Carbon preferred	116
Union Traction common	—
Union Traction preferred	—

Chicago Telephone for January gained 3,014 telephones, making the total now in use 173,789.

TELEPHONE AND TELEGRAPH.

MUSCATINE, IOWA—The Iowa Bell Telephone Company will shortly double its present capacity in the city by the laying of additional underground cables.

RENO, NEV.—The Northern Nevada Telephone and Telegraph Company has completed a line from Lovelock to Vernon. This line is to be extended at once to Rosebud.

TRAVERS CITY, MICH.—The Lake Ann & Oviatt Telephone Company has been organized at Oviatt. The company will build a ten-mile line from Lake Ann to Oviatt with branches. Sufficient capital is subscribed to build the line.

WARREN, N. H.—At its annual meeting the Baker's River Telephone Company voted to raise its capital stock from $8,000 to $12,000. In the early spring the line will be extended from Warren to Haverhill to connect with the Eastman line.

ROME, N. Y.—At the annual meeting of the Rome Home Telephone Company the following directors were elected: John S. Wardwell, Daniel M. Hall, William J. Grogan, Charles H. Poole, John E. Mason, George R. Fuller and Frederick Zoller.

WHEELING, W. VA.—The Farmers' Telephone Company lines are to be extended to Bowman, Marshall county. The line is already in operation to Glen Easton. The Farmers' company connects with the Bell and National companies at the Moundsville corporation lines.

KANSAS CITY, MO.—At the annual meeting of the Missouri & Kansas Telephone Company the old directors were reelected as follows: F. P. Fish, Boston; F. C. Phillips, Boston; C. E. Yost, Omaha; J. R. Mulvane, Topeka; M. A. Low, Topeka; J. W. Gleed, Topeka; J. S. Chick, J. F. Downing and C. S. Gleed, Kansas City.

ALBANY, N. Y.—Articles of incorporation have been filed with the secretary of state by the Schoharie Valley Telephone Company. It will connect Lexington, Jewett, Hunter, Haines Hall and Tannersville. The capital is $2,000, and the directors are John Stickels, of Hunter, and N. Wesley Pross, John H. Gripman, George W. Dunham, Frank A. Ford, Frank C. Carr, Elmer Ploss, Samuel R. Lewis and Arthur Chatfield, of Jewett.

LOWVILLE, N. Y.—At a meeting of the board of directors of the Black River Telephone Company, officers for the term of one year were elected as follows: president, Charles W. Pratt, Boonville; vice-president, George R. Fuller, Rochester; treasurer, Charles W. Pratt, Boonville; secretary, W. R. McCann, Rochester; manager, J. J. Domser, Lowville. A dividend of five per cent upon the preferred stock of the company was declared.

WILLIAMSPORT, PA.—The stockholders of the Loyalsock Telephone Company, at their annual meeting, declared a dividend of six per cent. These directors were elected for the ensuing year: Dr. R. H. Milnor, R. H. Rothfuss, H. G. Casner, B. A. Henry, F. A. Hayes, W. A. Wilson, Ezra Heim, George Lipp and C. F. Wheeland. The officers of the company are: R. H. Rothfuss, president; R. H. Milnor, secretary; Ezra Heim, vice-president; F. A. Hayes, treasurer.

ALBANY, N. Y.—The United Message Company, of Albany, controlled by men interested in independent telephone properties in various parts of New York state, has acquired the stock of the Exchange Construction Company, of Albany, gaining control of independent telephone lines in Clinton, Franklin and St. Lawrence counties. The United Message Company recently secured control of lines in Rensselaer, Saratoga, Washington and Warren counties, and holds options through the Hudson and Mohawk valleys.

BUFFALO, N. Y.—Officers of the Frontier Telephone Company have been elected as follows: president, Burt G. Hubbell; first vice-president, Henry H. Persons; second vice-president, E. C. Lufkin; secretary, Byron L. Moore; treasurer, Raymond Bissell; directors, William H. Andrews, Martin Carey, Robert W. Chapin, William A. Douglas, Charles W. Goodyear, Robert R. Hefford, Burt G. Hubbell, Clark L. Ingham, Andrew Langdon, H. H. Littell, Thomas B. Lockwood, E. C. Lufkin, George D. Morgan, Henry H. Persons, George A. Plimpton.

MEDICAL LAKE, WASH.—The Medical Lake Telephone Company at its second annual meeting elected these directors: J. F. Goldback, C. H. Merrill, Stanley Hallett, G. V. Ellis and P. S. Irvine. G. V. Ellis is president, Stanley Hallett secretary and treasurer and J. F. Goldback manager. It was decided to place 500 shares of stock on sale at $1 for extensions and improvements. The company has sixty-eight telephones with Pacific states connections and ninety-one farmers' lines. Since the organization in June last the exchange has been run at a profit. The directors were able to declare a dividend of fourteen per cent after defraying all expenses.

PHILADELPHIA, PA.—The Woodland Exchange, in course of erection for the Bell Telephone Company, at the southeast corner of Fifty-fourth street and Woodland avenue, is intended to relieve the congestion of traffic in the other West Philadelphia exchanges. The building will be two stories high and of Colonial style. It will measure 65.4 feet on Woodland avenue and 124 feet on Fifty-fourth street. The lot cost $10,000 and the building will cost $81,000. The Charles McCaul Company has the contract. The switchboard equipment will cost $100,000. This will provide for an ultimate installation of 9,600 lines and 19,200 stations operated from the exchange. The operation of the boards will require thirty-six operators.

RUTLAND, VT.—The incorporation of the Vermont Home Telephone Company, which was recently granted a charter to operate an independent telephone service by the Vermont legislature, met in Rutland and organized by electing the following board of directors: Clarence O. Perkins, Charles S. Caverly, Fred A. Field and Warner H. Baldwin, of Rutland; Irving H. Griswold, Howard Hendrickson and Irving R. Coughtry, of Albany; Frederick H. Sudro and Theodore M. Brush, of Elyria, Ohio. Assurances are given that the company will begin operations in Vermont in the early spring by the construction and installation in Rutland of a modern up-to-date telephone exchange. The principal members of the new company control the interests of the Home Telephone Company and of the United Message Company, which covers the territory of all of eastern New York.

SAN FRANCISCO, CAL.—Announcement is made that the Pacific States Telephone and Telegraph Company and the Sunset Telephone and Telegraph Company have been merged into one company, and that their various properties and systems, reaching every part of the Pacific slope, will be taken over by a company called the Pacific Telephone and Telegraph Company. The consolidated company has been capitalized at $50,000,000. Of this there will be $32,000,000 preferred stock and $18,000,000 common stock. Vast expenditures and improvements are planned. To meet the details of these plans fully $35,000,000 of five per cent bonds will be issued. This sum is expected to be almost immediately available. Part of the agreement calls for a six per cent dividend on the preferred stock. President Henry T. Scott will remain president of the new company.

NEW PUBLICATIONS.

REPORT OF THE LIGHT-HOUSE BOARD—The annual report of the Light-House Board to the secretary of commerce and labor has been issued. This is dated June 30, 1906.

JOHNS HOPKINS UNIVERSITY—The Johns Hopkins University, Baltimore, Md., has issued university circular No. 1 (1907). This contains the report of the president, reports of instruction in the chief branches of study, a tabular statement of the courses of instruction, report of the registrar, degrees conferred and other interesting information.

BULLETIN OF THE MASSACHUSETTS INSTITUTE OF TECHNOLOGY—The January bulletin of the Massachusetts Institute of Technology, Boston, Mass., contains the seventh annual report of President Henry S. Pritchett, and the reports of the various departments. There are now enrolled 1,397 students, 535 of whom were not connected with the school in 1905-1906.

NEW MANUFACTURING COMPANY.

DETROIT, MICH.—Articles of association for the Detroit Gas and Electric Light Fixture Company have been filed. The capitalization is given as $15,000 and the stockholders are as follows: William Ryan, Charles A. Coppock, Fred G. Lafferty.

INDUSTRIAL ITEMS.

THE TRENTON PORCELAIN COMPANY, Trenton, N. J., announces that E. O. McDowell will represent the company at 154 Nassau street, New York city.

DODGE & DAY, Philadelphia, Pa., announces that John E. Zimmermann, formerly secretary of the American Pulley Company, Philadelphia, has become a partner in the firm.

THE CRANE COMPANY, Chicago, Ill., has its new steel foundry in full running order. In this department steel valves and fittings will be a specialty and facilities are available, so that promptness in filling orders is assured.

THE PHILIP CAREY MANUFACTURING COMPANY, Cincinnati, Ohio, has ready for distribution a handsome booklet devoted to Carey's flexible cement roofing for modern buildings. This booklet will be sent to any one interested upon request.

THE GENERAL ELECTRIC COMPANY, Schenectady, N. Y., has ready for distribution a handsome catalogue devoted to electric heating and cooking appliances. This catalogue is printed in colors and is a very attractive addition to the literature of the subject. A perusal of this catalogue is decidedly satisfactory, as it not only gives a very good idea of the utility of electrical cooking apparatus, but shows how it may be applied; and, more important than anything else, gives exact figures with regard to the consumption of electricity, the capacities and list prices of the apparatus. This catalogue should be especially attractive to central station managers.

THE ELECTRIC STORAGE BATTERY COMPANY, Philadelphia, Pa., has recently issued a folder describing the application of chloride accumulators and Exide batteries to stationary gas or gasolene engines. The folder illustrates the system of battery ignition with these cells, both in stationary form, where charging current is available, and in portable form, where it is necessary to carry the batteries to a convenient charging source. Illustrations, dimensions, weights, capacities and prices of the two-plate types of chloride accumulator and of the Exide sparking batteries are given, with a diagram of connections and explanations showing the methods of determining the necessary resistance for cutting down the line voltage from an ordinary lighting circuit. This folder will be sent to any one interested upon request.

THE CROCKER-WHEELER COMPANY, Ampere, N. J., announces the following orders received within the last few weeks: Bridgeport Malleable Iron Company, Bridgeport, Ct., one 200-kilowatt direct-current generator and one ninety-kilowatt direct-current generator; Pittsburg & Baltimore Coal Company, Wendel, Pa., one 300-kilowatt direct-current generator; W. & J. Knox Net and Twine Company, Baltimore, Md., twenty-five twenty-five-horse-power, direct-current, 230-volt motors; Bridgeton Electric Company, Bridgeton, Ct., one 500-kilowatt direct-current generator; Alliance Machine Company, Alliance, Ohio, seventy-four motors ranging from six to 100 horse-power; Bosches' Troy Laundry, Austin, Tex., fourteen motors ranging from one-eighth to seven and one-half horse-power, and one thirty-five-kilowatt generator. In many cases these are additions to the electrical equipment, which is composed principally of Crocker-Wheeler apparatus.

Record of Electrical Patents.

Week of February 5.

842,849. ELECTRIC HEATER. Arthur N. Anderson, Niagara Falls, N. Y. The heater is in sections, each separated from the adjoining ones by insulation.

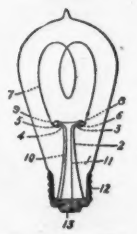
842,852. ELECTRICAL CONTACT APPARATUS. James C. Boyd, New York, N. Y. A third-rail shoe.

842,861. AUXILIARY FIRE-ALARM BOX. Frederick W. Cole, Newton, Mass., assignor to the Gamewell Fire-Alarm Telegraph Company, New York, N. Y. The alarm is released by an electromagnet.

842,867. BATTERY. Frank A. Decker, Philadelphia, Pa., assignor to Decker Electrical Manufacturing Company, Wilmington, Del. A metal envelope has a bottom of non-conducting material pierced by a conduit.

842,875. X-RAY TUBE. Mylius Ehrhardt, Berlin, Germany. The anticathode is enclosed in a lead-glass tube.

842,910. WIRELESS COMMUNICATION. Greenleaf W. Pickard, Amesbury, Mass. The wave-interceptor is shielded by a conductor containing impedance and resistance.



843,054. INCANDESCENT ELECTRIC LAMP.

842,911. ELECTRIC BELL. Henry E. Reeve, Brooklyn, N. Y. A method of construction.

842,918. TYPE-PRINTING TELEGRAPH. Edwin J. Steljes, London, England. A printer of the Wheatstone type.

842,930. RAILWAY SWITCH. Thomas K. Wilson, Chillicothe, Ohio. An auxiliary electrical locking device is provided.

842,941. INSULATOR. Walter G. Clark, New York, N. Y. The insulator is elongated in the direction of the wire and the pin is provided with a brace.

842,942. WIRE INSULATOR. Walter G. Clark, New York, N. Y. Wire clamps are attached to an overhanging upper edge.

842,945. BATTERY ELEMENT. Frank A. Decker, Philadelphia, Pa., assignor, by mesne assignments, to Decker Electrical Manufacturing Company, Wilmington, Del. A carbon battery plate.

842,950. BATTERY CELL. Hugo Gernsback, New York, N. Y., assignor to Royal Battery Company. A number of cells, spaced apart and clamped, and means for carrying.

842,951. VENTILATION OF ELECTRIC MOTORS. George Gibbs, New York, N. Y. Air for cooling the motors is delivered through an air passage in the swiveling connection.

842,957. ELECTRIC CAR AND LOCOMOTIVE. Coloman de Kandó, Budapest, Austria-Hungary, assignor to Westinghouse Machine Company. The bearings centering the rotating part yield in the direction of the driving strains, and the bearings for the rotating part are unyielding in this direction.

842,963. DYNAMO-ELECTRIC MACHINE. Marius C. A. Latour, Paris, France, assignor to General Electric Company. The number of turns in the width of the commutator sections vary in a sine function.

842,966. METHOD OF OPERATING ELECTRIC MOTORS, GENERATORS, AND OTHER APPARATUS. Ralph D. Mershon, New York, N. Y. Poles are produced in separated groups in which the angular distances correspond to the speed desired.

842,971. WINDING MECHANISM FOR SELF-WINDING ELECTRIC CLOCKS. Henry W. Porter, Forestville, Ct., assignor to New Haven Clock Company, New Haven, Ct. The oscillating winding-arm is moved by a magnet.

843,005. AUTOMATIC ELECTRIC TIME-SWITCH. Leslie C. Dorland, Poughkeepsie, N. Y. The clock controls a spring-released switch.

843,033. FLUID-PRESSURE REGULATOR. Walter J. Richards, Milwaukee, Wis. The switches controlling the motor are themselves controlled by the pressure of the fluid.

843,039. TRAIN-DESPATCHING SYSTEM. Charles E. Scribner, Jericho, Vt., assignor to Western Electric Company, Chicago, Ill. An electromagnetically operated signal.

843,053. TELEPHONE SWITCH. Klas Weman, Buffalo, N. Y. A switch for a hand telephone.

843,054. INCANDESCENT ELECTRIC LAMP. Willis R. Whitney, Schenectady, N. Y., assignor to General Electric Company. The leading-in wires pass through tubes closed by metal caps.

843,078. TELEPHONE SYSTEM. Richard M. Eaton, Philadelphia, Pa., assignor to Keystone Telephone Company, Philadelphia, Pa. A party-line system.

843,155. MOTOR-METER FOR ALTERNATING CURRENTS AND METHOD OF OPERATING THE SAME. Robert C. Lanphier, Springfield, Ill., assignor to Sangamo Electric Company, Springfield, Ill. The armature rotates in a conducting fluid.

843,182. CIRCUIT-CLOSING MECHANISM FOR INDICATORS ON CARS. Thomas W. Small, Cleveland, Ohio, assignor, by mesne assignments, to the Acme Automatic Street Indicating Company, Cleveland, Ohio. A contact carried on the trolley-harp closes the indicating circuit.

843,186. TELEPHONE DICTATING MACHINE OR APPARATUS. Kelley M. Turner, New York, N. Y., and William F. H. Germer, Hoboken, N. J.; said Germer assignor to said Turner. Loud ear-pieces are provided.

843,189. MEASURING INSTRUMENT. George M. Willis, Chicago, Ill. The record is made by electrical discharges from the indicating needle.

843,245. TELEPHONE TRUNKING SYSTEM. Harry G. Webster, Chicago, Ill., assignor to Kellogg Switchboard and Supply Company, Chicago, Ill. Two signals are provided.

843,261. ELECTRIC TRAM-CAR. George J. Conaty, Smethwick, England. A four-wheeled truck with swiveling axles.

843,266. SYNCHRONIZER. William H. Freedman, Burlington, Vt. Utilizes the rotating magnetic field produced within a ring.

843,267. FREQUENCY-METER. William H. Freedman, Burlington, Vt. The frequency is measured by means of the phase displacements produced in two coils.

843,270. CIRCUIT-CATCHING DEVICE AND ELECTRICAL SYSTEM FOR USE IN CONJUNCTION WITH THE SAME. Albert H. Graves, Chicago, Ill. A circuit-catching device for a telephone system.

843,276. AUTOMATIC ELECTRIC SWITCH. William F. Irish, East Orange, N. J. The switch is thrown by a float.

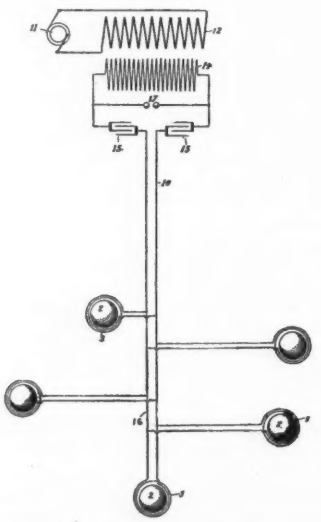
843,281. LAMP-SOCKET FOR INCANDESCENT LAMPS. Charles M. Keier and Edwin W. Keier, Toledo, Ohio. A porcelain socket.

843,283. ELECTRIC SIGNAL. Charles L. Krum, Chicago, Ill. A polarized bell.

843,286. POWER-TRANSMISSION MECHANISM. Robert H. Little, Chicago, Ill., assignor to Talbot & Holst, Chicago, Ill. A magnetically driven ratchet-wheel.

843,287. ELECTRIC MOTOR. Andrew T. MacCoy, Dover, Mass. A rotatable armature surrounded by a non-rotatable coil.

843,296. TELEPHONE RELAY OR REPEATER. Albert L. Parcelle, Boston, Mass. The pressure on the microphone is varied by a pivoted magnet resting against it.



843,534.—METHOD OF PRODUCING ELECTRIC LIGHT.

843,305. TROLLEY WHEEL. Adam A. Schneider, Camden, N. J. A renewable trolley wheel.

843,310. INCANDESCENT-LAMP SOCKET. George B. Thomas and Gilbert W. Goodridge, Bridgeport, Ct., assignors to the Bryant Electric Company, Bridgeport, Ct. A method of construction.

843,312. MAGNETIC WORK-HOLDER. Walter N. Vance, Chicago, Ill. A supplemental magnetic lift.

843,316. ATTACHING MEANS FOR ELECTRIC LAMPS. Earl G. Wilson, Morrow, and William B. Goodwin, Columbus, Ohio. An elastic cup is attached to the socket.

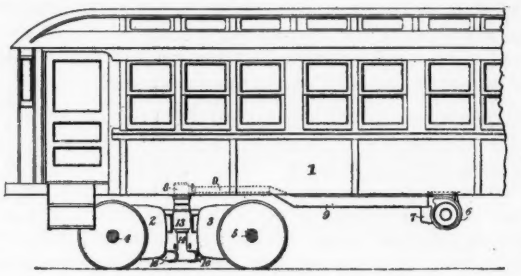
843,327. AUTOMATIC CIRCUIT-CLOSER. Leandre Charbonneau, Woonsocket, R. I. The alarm-circuit is closed by the breaking of a fusible wire.

843,329. INTERCOMMUNICATING TELEPHONE SYSTEM. William W. Dean, Chicago, Ill., assignor to Kellogg Switchboard & Supply Company, Chicago, Ill. Three conductors are provided for each substation.

843,362. ATTACHMENT FOR MOUTHPIECES OF TELEPHONE TRANSMITTERS. William C. Plank, Las Flores, Mexico. The mouthpiece is lined with antiseptic paper.

843,414. OPTICAL READING DEVICE FOR ELECTRICAL MEASURING INSTRUMENTS. Edwin F. Northrup, Philadelphia, Pa., assignor to Leeds & Northrup Company, Philadelphia, Pa. A telescope and mirror attachment.

843,415. ELECTRICAL SYNCHRONISM. Edwin F. Northrup, Philadelphia, Pa., assignor to Leeds & Northrup Company, Philadelphia, Pa. The frequency of the circuit is damped by a synchronizing ohmic resistance.



842,951.—VENTILATION OF ELECTRIC MOTORS.

843,418. SINGLE-RAIL ELECTRIC OVERHEAD RAILWAY WITH SUSPENDED VEHICLE. Hippolyte Romanoff, St. Petersburg, Russia. A suspended railway.

843,425. INCANDESCENT LAMP SOCKET. Frederick Wunderlich, Swissvale, Pa. A spring-contact is provided in the socket.

843,489. PARALLEL RUNNING OF DYNAMO-MACHINES. Charles A. Parsons and George G. Stoney, Newcastle-upon-Tyne, England; said Stoney assignor to said Parsons. An equalizer is connected between intermediate points on the series coils.

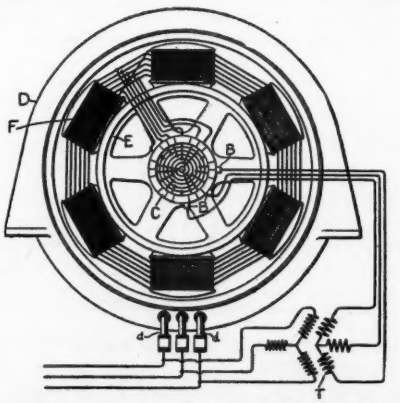
843,508. PRINTING TELEGRAPH. James D. White, London, England. Uses a rotating printer.

843,515. PROCESS FOR ELECTRICALLY WELDING THE LONGITUDINAL JOINTS IN TUBULAR OBJECTS. Emil Bier, London, England. The joints are welded by induced currents.

843,520. ELECTRIC TRAM SYSTEM. Orrin J. Davy, Washington, D. C., assignor to Industrial Motor Company. A light suspended railway.

843,533. INDUCTION VAPOR OR GAS ELECTRIC LAMP. Peter C. Hewitt, New York, N. Y., assignor, by mesne assignments, to Cooper Hewitt Electric Company. Vapor in an enclosed chamber becomes incandescent from induced currents.

843,534. METHOD OF PRODUCING ELECTRIC LIGHT. Peter C. Hewitt, New York, N. Y., assignor, by mesne assignments, to Cooper Hewitt Electric Company. An enclosed vapor is utilized as the secondary in which currents are induced by a primary coil.



842,963.—DYNAMO-ELECTRIC MACHINE.

843,541. INDUCTOR MAGNETO-ALTERNATOR. Leon J. Le Pontois, New Rochelle, N. Y., assignor to Polyphase Ignition System Company. Currents are induced by the movement of the armature poles.

843,549. RECEPTACLE FOR ELEMENTS. Heinrich P. R. L. Pörscke and Gustav A. Wedekind, Hamburg, Germany; assignor to said Wedekind. A cast-iron receptacle for copper oxide plates.

843,550. ELECTRIC SIGNALING SYSTEM. Frank W. Prentice, Chicago, Ill. An electric block-signaling system.